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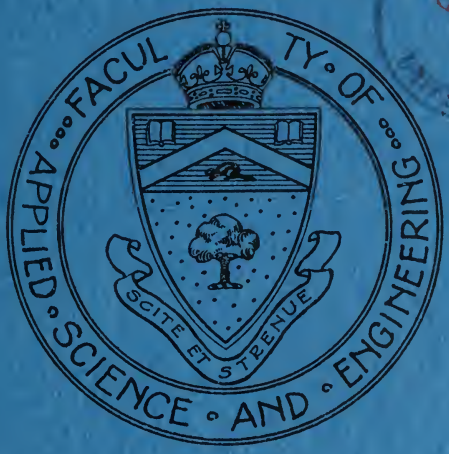


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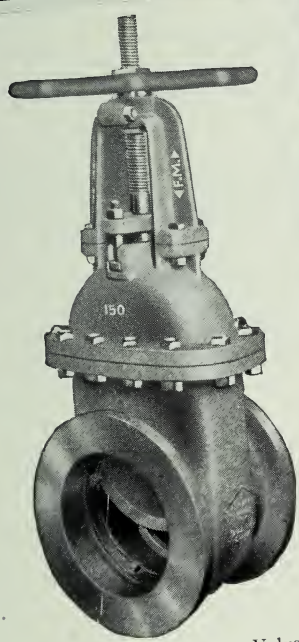


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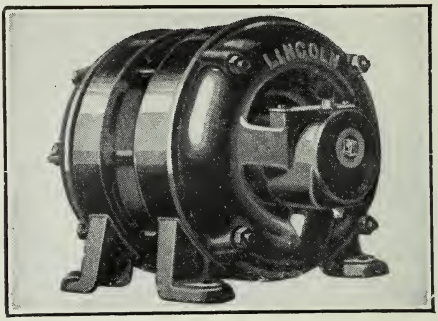


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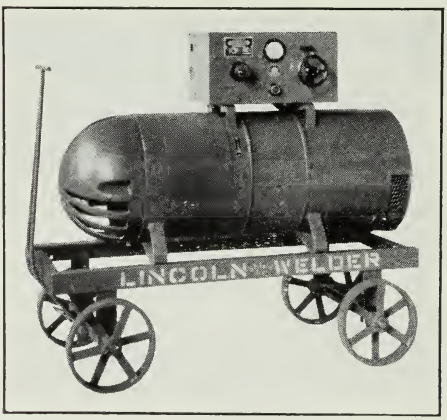


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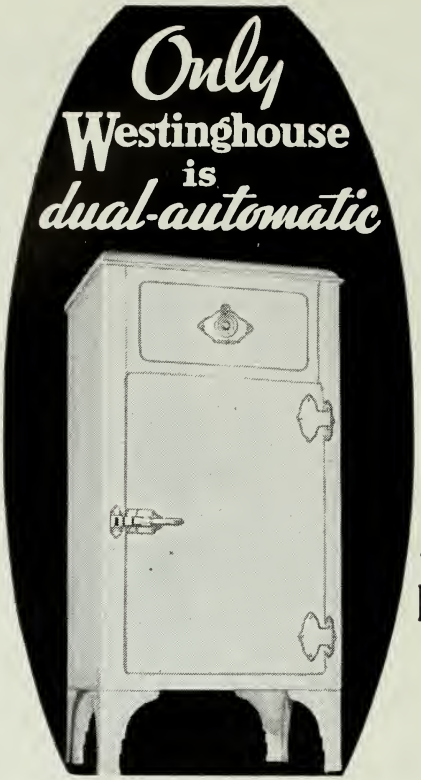

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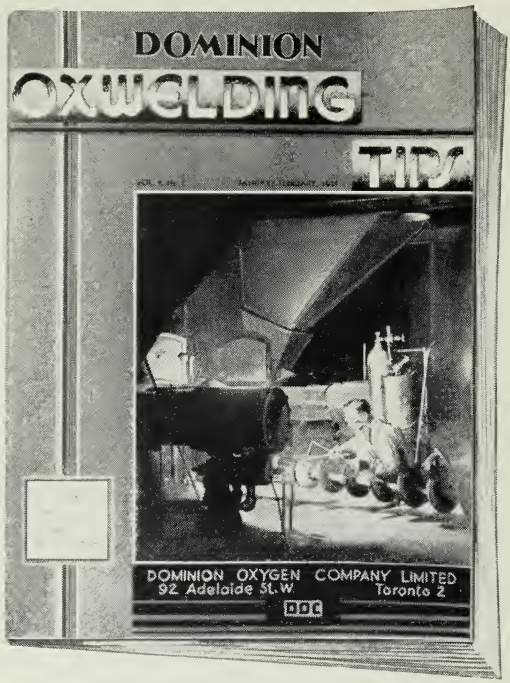


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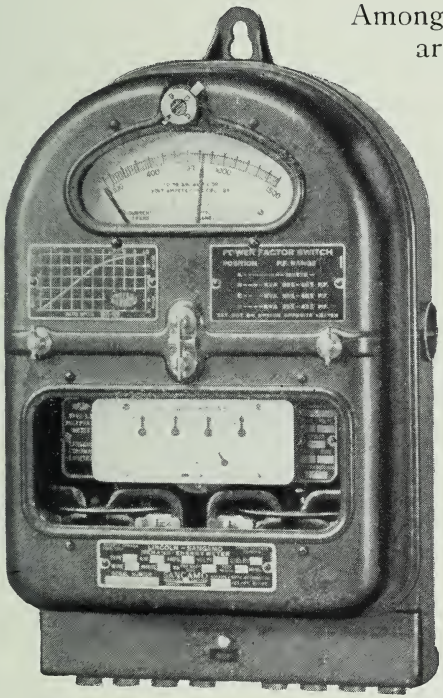

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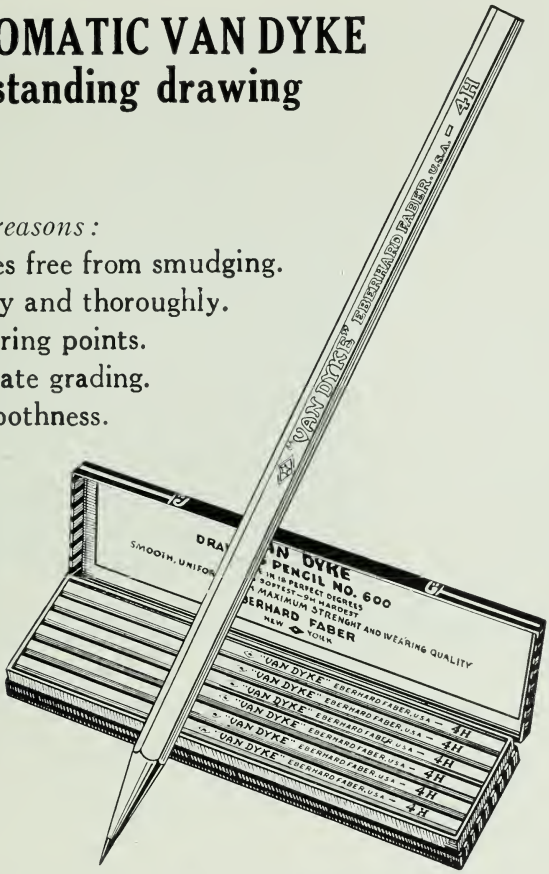


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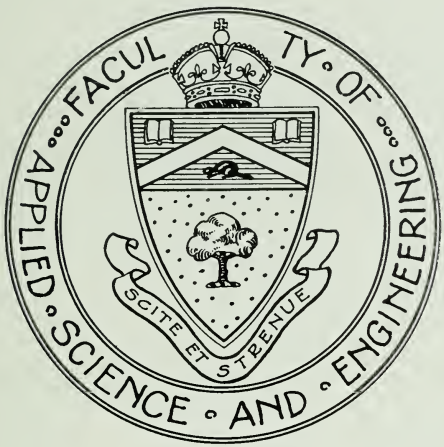


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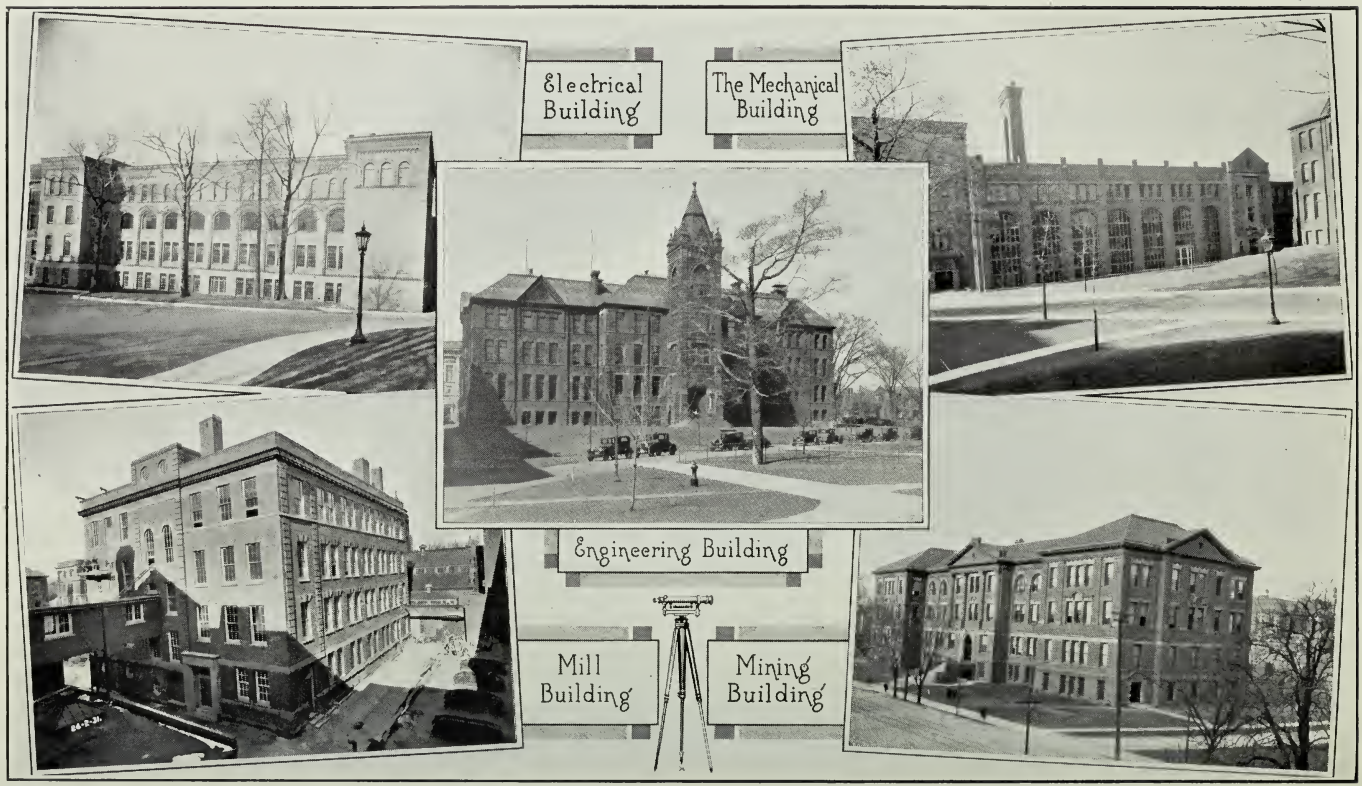
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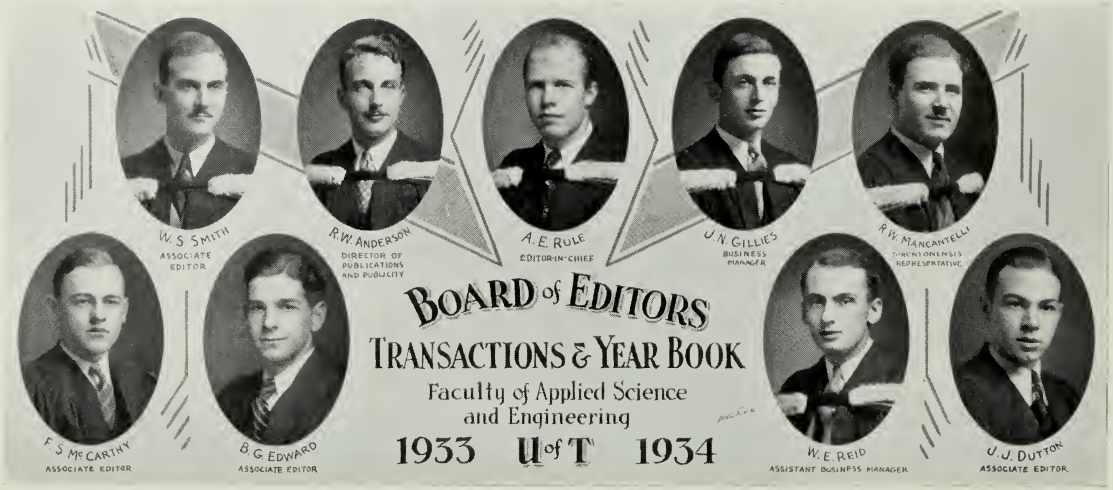
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# TRANSACTIONS AND YEAR BOOK

OF THE

## UNIVERSITY OF TORONTO ENGINEERING SOCIETY

No. 47 APRIL, 1934



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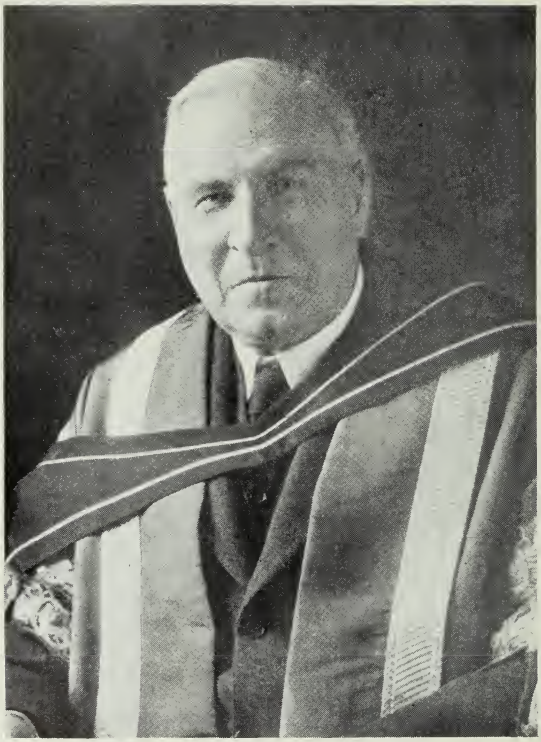
*Associate Editor*


# EDITORIAL

TRANSACTIONS is a rather unique publication in that there is no clearly defined policy as to the contents or appearance, all details being left entirely to the discretion of the board. With this in mind we offer this—the fourteenth edition—with befitting humility.

We have attempted to make this as interesting to the alumni as to the undergraduate. The addresses given before the Engineering Society constitute the first section of the book in a condensed form. Several very interesting addresses were illustrated with lantern slides and diagrams to such an extent as to make them impossible for publication. Thus we have been compelled to leave them out. The last part of the book is more properly "School". In brief, it is our Year Book, and as such constitutes another page in the history of our Faculty. To the undergraduate it presents, in permanent form, a record of his interests during one of his years here. To the graduate it forms a connecting link with "School".

And so we give you TRANSACTIONS. And may we take this opportunity of thanking those of our advertisers who have stayed with us despite conditions. We would also like to extend our thanks to the members of the Faculty, graduates and undergraduates, who have given their assistance and co-operation in making this publication possible.



THE HON. AND REV. H. J. CODY, M.A., D.D., LL.D.
President of the University of Toronto

# MESSAGE FROM PRESIDENT CODY TO THE ENGINEERS

With much pleasure I again send hearty greetings to the members of the Engineering Society and congratulate you on the excellent addresses contained in this volume and on the high standard of work maintained throughout the year. Whatever you do, you do it with your might. Into work and recreation you put your whole selves.

Many interesting researches are in process in your Faculty, which will prove, I hope, of great practical value to our country. It was specially gratifying to me to know that most of the prizes offered by the Canadian Institute of Architecture were won by men and women from our own School of Architecture. This must delight the heart of Professor C. H. C. Wright, the esteemed head of this department. To him and to Professor Anderson, who retire this year, I offer the University's sincere thanks for their long, faithful, and efficient services. May every blessing attend them in their years of comparative rest, and may their leisure be full of interest and activity!

I have this year carefully visited every part of the buildings in which your activities are housed. It is most encouraging to observe the general keenness of staff and students and the ingenuity with which every available foot of space has been occupied.

During this year a very large benefaction has been received under the will of the late Miss Marie Wallberg, in memory of her brother, the late Mr. Emil Wallberg, for the development of the work of Applied Science and Engineering. The utlimate destination of this gift has not yet been determined, but in the meantime from the interest on part of the money available a Wallberg Memorial Loan Fund has been established for this year in aid of students in the third and fourth years.

Your course of training fits you admirably to be constructive citizens of Canada. I hope that the evident, though gradual, renewal of business will offer you opportunities for work in Canada. Nothing can really keep Canada back, except the folly of its citizens. Hold fast and look forward. Your University is proud of you; I trust you will always be proud of and helpful to your Alma Mater. May real success always attend you.

H. J. Cody

# THE DEAN'S MESSAGE FOR 1934

To the Members of the Engineering Society:

*Gentlemen:*

The present year of the Engineering Society has been one of very considerable success and progress. The types and quality of the papers given before it have been of a high order, and the Society has been fortunate in having eminent engineers and citizens address its meetings, giving valuable technical papers and sound advice and views, which, at this time, have been very useful and inspiring. In this respect this Session will be distinctly remembered by the members of the Society. I congratulate the President, the Officers, and the Executive upon these accomplishments and successes.

Through these addresses, the undergraduates remaining and the graduates who will be going out into the world this year will carry with them the high principles and advice which have been presented to them, thus broadening their applied science training and general education. They can more readily make the best use of all facilities to continually acquire engineering and other knowledge so necessary for their equipment as engineers and citizens for whatever they may be called upon to do.

We cannot shut our eyes to the difficulties of the depression that have beset us in the past few years, but again I point out that engineers have really been better off than most other professions. One could almost say the same of architects, although with the qualification that the construction industries have been harder hit than any. However, one hears—and sees—on all sides now, that we are approaching better times and although we have not yet definitely "turned the corner", we can see that the road is really

turning, slowly though it may be. Well, perhaps it is better that we make the turn slowly. In any case, let us have patience and perseverance and we shall soon "straighten out" on the new course

If it has been a long hill we have been climbing, we can be sure that in Canada the road will take us to a high level again, where we shall carry on with the prospect of all the great advantages that are presented to those of us who inhabit this fortunate country. Our natural resources are not impaired and we have the ability and training to take up their development along the new road, having gained the experience which comes to those who have toiled along the rough journey through the valley. Long and discouraging though it has been at times, we shall all shortly get our reward in the more prosperous times for engineers and architects that are most assuredly ahead of us in Canada.

"Stand straight; step firmly, throw your weight;
The heaven is high above your head,
The good green road is faithful to your tread.
Be strong: sing to your heart a battle song;
Though hidden foemen lie in wait,
Something is in you that can smile at fate."

With best wishes for success and good fortune to you all,

Yours faithfully,

C. H. MITCHELL,
*Dean.*

March, 1934.

# PRESIDENT'S MESSAGE

SCHOOLMEN:

The Engineering Society during the past year has maintained its position as the foremost student organization of the University. This is no idle boast, for the admiration expressed by students of other faculties proves the truth of the statement. The success of the activities of the Society is well known about the campus and is the envy of undergraduates. It has taken years for the continued efforts of able Schoolmen with the aid of members of the Faculty to build up the organization in which you may feel a just pride.

I will review briefly the chief activities of the year. The Freshmen were greeted warmly or coldly as the circumstances warranted. by the vigilant Sophomores. Green ties were soon very much in evidence. Fortunately, tie-clipping is gradually being abandoned. This is a good thing, for we want every Freshman to be proud that he has entered School, and that is rather difficult if he is compelled to go about the campus for days displaying the remnants of a tie.

In common with most other colleges throughout the Dominion, School has discarded the old type of initiation. Instead, the Sophomores and Freshmen held what is termed an Initreception, at which they managed to get better acquainted with one another. Bob McIntyre laid his plans well for this function. The First Year, under Len Sharpe, responded with a most successful Soph-Frosh dance.

The first few days after registration were busy ones in the Supply Department. But the Manager, Don Ritchie, was prepared for the rush and handled it most efficiently. Throughout the year he investigated many means for increasing the sales and bettering the service, and his efforts have brought results, as is shown by the annual financial statement.

The School Dinner on December 5 was a momentous occasion. Schoolmen gathered to enjoy the best victuals that Hart House can provide, and to hear an inspiring address from Dr. Lefebvre. The ambition of years was realized when Sir William Mulock presented the Mulock Cup to the Senior School football team. The success of the dinner was due to the untiring efforts of Stan. Smith. During this year he has superintended the social activities admirably. The School At-Home was the best for years. The greatly increased attendance was due in a large measure to the energetic advertising campaign by which Stan and his committee made everyone School At-Home-conscious.

School Nite proved to be as popular as ever. Ted Douglass as chairman and Bob Doull in charge of skits were chiefly responsible for this enjoyable function.

The general meetings were far from being the bugbear that several of the past presidents complained of. A few years ago the policy of having meetings at irregular intervals was adopted, in the belief that in this way it would be easier to secure able speakers. But this year we have followed the calendar very closely, and the attendance indicates that this policy is preferable. The Club Chairmen co-operated with your President in obtaining speakers, who have given splendid addresses on a wide variety of subjects. However, there is still room for improvement in the matter of attendance, for though C-22 was filled for most of the meetings, there were two or three when the audience was disappointingly small. It is very discouraging to ask a prominent man to give an address to the Engineering Society and to have less than a hundred Schoolmen come to hear it. On these occasions the topics were of a non-technical nature, giving Engineers an opportunity to broaden their interests, and the indifference shown is regrettable.

The School elections were as noisy and exciting as ever. Lorne Shepherd kept a watchful eye on the proceedings and controlled them exceptionally well.

Every department of Toike Oike has been ably managed. Our Director of Publications, Bob Anderson, and his staff may well feel proud of the paper. Bob also did good work in advertising the general meetings and leading the sing-songs. The Transaction's advertisements have been greatly increased this year due to the untiring efforts of John Gillies, Al Rule and Bill Reid.

A number of needed changes have been made in the Supply Department. A new cash register greatly simplifies the handling of the money. The construction of an inner office facilitates the work of the Executive. It also provides a suitable place for Miss Bradshaw, the mainstay of the Society, to work with a minimum of interruption. By hiring an assistant, it has been possible to keep the store open continuously from 9 till 5, and also to improve the service over the counter.

The finances of the Society have been well handled by the Treasurer, Bob Hewitt.

The Clubs have been very active this year, especially the Chemical, Mining and Metallurgical, Mechanical and Architectural Clubs, and the chairmen are to be congratulated on the results of their efforts.

The Athletic Association, ably managed by Harp McNichol, has kept up the prestige of S.P.S. in Interfaculty sport, and has won a goodly number of championships. Foremost of these is the Mulock Cup; we are all proud of the team which fought its way to victory and brought that coveted trophy to School.

I have been especially fortunate this year in having an Executive, the members of which delighted in taking responsibilities, and fulfilled them most creditably. You and all the Schoolmen who

have worked to make the School functions so successful have my sincere thanks. Dean Mitchell, Professors Treadgold and Wright and other members of the Faculty have also contributed to the success of the Society, and I greatly appreciate their advice and co-operation.

Schoolmen, I thank you for all that it has meant to have been your President. To Don Ritchie, your new President, and his Executive, I extend hearty congratulations and best wishes for future success.

C. W. Tyson.

1934

# TRANSACTIONS

OF THE

## UNIVERSITY OF TORONTO ENGINEERING SOCIETY

FACULTY OF APPLIED SCIENCE
AND ENGINEERING

UNIVERSITY OF TORONTO

# GRADE SEPARATION

*Condensed from a Thesis for the Degree of B.A.Sc. in Civil Engineering*

BY N. E. TREGASKES

Grade separation is becoming one of the major problems in railway work. It is especially serious to the railroads in that there may be a large number of projects contemplated of which the total cost would be enormous and out of all proportions to the benefits derived.

*How Grade Separation is Generally Advocated*

Grade separations are advocated by the public mainly on the basis of safety and convenience of traffic, by the elimination of interferences at grade crossings. As a general rule, the public, by popular or political demand, pass ordinances calling upon the railroad to effect the elimination of a certain hazardous level-crossing. Often the public takes this initiative by obtaining direct orders issued by the state or other municipal authorities (it may be the Board of Railway Commissioners of Canada), condemning the crossing; but sometimes the elimination is accomplished by mutual agreement. Railroad managers may co-operate with the public, and it is evident that this course is by far the best. By so doing, the railroad can bring plans that will meet the requirements and be most economical. Generally, the public does not give much thought to the costs of such projects.

*A Comprehensive Survey is Desirable*

In urban centres, a comprehensive survey should first be made. This is the most logical and economical method, when many lines, streets and often industries are involved. In this way, some basic plan may be adopted. Portions of this plan could then be taken up as conditions required them. Each distinct unit, however, must be studied as a separate project. Such a comprehensive survey was made in Detroit a few years ago. A basic plan was studied, and the work outlined to suit certain conditions. The idea was that streets or districts of heaviest traffic would be handled first, and the work so distributed that no one railroad would be unduly burdened. It was estimated to cost about $40,000,000, and would be completed about 1938. Unfortunately, the city authorities did not adopt this plan, but the method of approaching the problem was very sound.

## Objections to Grade Separation by Railroads

The railroads often object to grade separation on the following principal grounds:

(1) There is often an increase in existing grades. This naturally involves an increase in operating costs, and there will be a decrease in train tonnage over the given grade. In some grade separation projects involving comparatively long distances, the runoff grades vary from .6% to as high as 1.5%.

(2) There is a restriction of railway expansion. Any separation of the main-line grade from the contiguous territory limits the opportunity for expansion. Therefore, in such undertaking, due consideration should be given to the requirements of the future. Right-of-way for future tracks and design of future structures must be provided.

(3) Industrial track connections and train-yard tracks may become involved. Where the separation involves industrial areas, there is objection due to the difficulties and expenses of connecting the industry tracks to the elevated or depressed ones. This is often a very troublesome factor. If the spur tracks are kept at the same level, there may have to be steep approaches, varying sometimes from 2½% to 3½%; while putting the spur at the new level may cause inconveniences to the industries concerned. There is a further difficulty where the tracks extend across streets adjacent to the right-of-way. So far as industrial track layouts are concerned, track elevation is preferable to depression. Indeed, for many industries such as coal, sand, ore, etc., track elevation is of special benefit. This is where a comprehensive survey is desirable. The railroad, municipal authorities and officers of the industries concerned should have advanced discussions, which may very often eliminate the difficulties. Co-operation, compromise and due regard for the rights of each party are imperative for solving such a problem.

(4) The capital investment is increased with a consequent increase in taxes and fixed charges.

(5) The quality of service is not appreciably improved nor is there any additional revenue.

(6) Structural maintenance costs are increased.

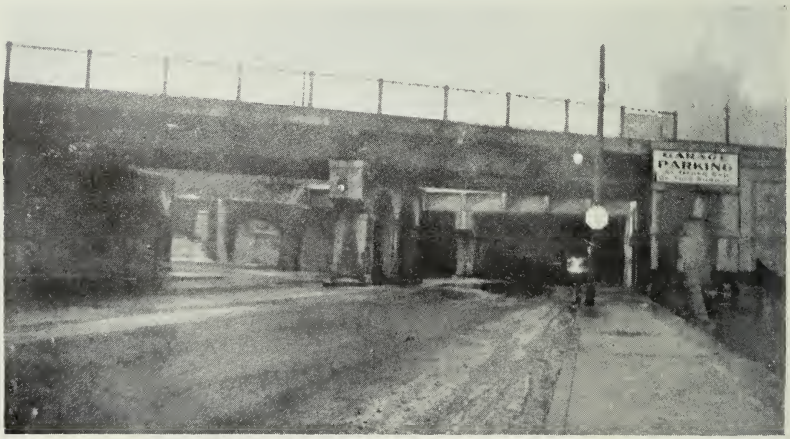
Generally, elevation is less objectionable than depression and future expansion will be less expensive to accomplish. Drainage problems will be more easily handled and there will be less disturbance of existing improvements.

## General Methods of Separating the Grades

Although there may not seem to be a marked distinction in the manner of treatment of grade separation structure from other structures, nevertheless there are features not common in other projects that claim the attention of the civil engineer. The primary engineering problem in grade separation work is the alteration of existing grades. This may be done in several ways, viz., the total elevation or total depression of either highway or railroad, or the partial elevation of one and partial depression of the other.

Several factors govern the method of separating the grades. (1) The cost, of course, is a primary consideration. (2) The relative

Deck structure with centre pier. I beams are encased in concrete and are at right angles to the track. (Lake Shore Blvd., Toronto)




Deck structure composed of plate girders running parallel to the centre line of the track. (York St., Toronto)

importance of highway and railroad is very important. (3) The topography of the country may sometimes be the governing factor in that it may vitally influence the drainage problems. It must also be remembered that the railroad right-of-way is 100 ft. in width, while that of the highway is 66 ft. in width. Grade separation structures are built to span these in the most feasible manner.

## The Influence of Centre Columns on Typical Railroad Grade Separation Structures

The use of centre columns is of vital importance in the design of grade separation structures. There are no definite statutes as to the use of centre columns, but municipal authorities and the Railroad Commission must first give their approval. Sometimes objections are raised in that centre columns create a hazard. Obviously where a three-lane highway exists there would be danger; but for a four-lane or a six-lane highway there is no appreciable danger if suitable precautions and safety measures are taken.

For a two-lane highway there is no economic advantage in using centre columns, but for a four-lane highway, centre columns are advantageous, both from the standpoint of economy and good railroad practice.

### *The Suitability of Deck Structures*

A deck structure is most desirable from a railroad viewpoint. This allows a more flexible track layout, and where two or more tracks are involved, no spreading of track centres is necessary. Deck bridges are also safer than other types and do not interfere with visibility. Whereas, for some types of through two-track bridges, it is necessary to install the complete bridge at one time, a deck structure can be placed under existing tracks and installed separately for each track and thus there is a minimum inconvenience to railroad traffic. Future tracks can also be added on standard centres without disturbing the existing ones.

### *Arguments in Favour of Centre Columns for Deck Structures*

Assuming a right-angled bridge, no sidewalks and a four-lane highway (or, in other words, a forty-foot roadway), the shortest span between abutments in a grade separation is about forty-five feet. This will be increased with the number and width of traffic lanes, the angle of skew, and the width of sidewalks, if provided. A typical condition of a four-lane highway with two sidewalks and a skew angle would give a span of approximately seventy feet. Obviously, from an economical point of view, a deck structure of seventy feet is out of the question due to the extra cost of providing for the necessary excess floor depth over that required for a through bridge. If a deck structure is built with an economic floor depth, instead of a through bridge, it would be necessary (1) to depress the highway considerably more than for a through bridge, (2) or to elevate the tracks that amount, (3) or to provide a combination of the

two. In the first case, the lengthening of the grades with the extra grading, pavements, land, etc., would cause a considerable extra expenditure. In the second case, the raising of the tracks under traffic would cause additional costs. Sometimes if this is attempted the layout of the highway and railroad will not permit a radical change in profile. For example, railroad bridges in the vicinity form control points as to the amount of track raise economically possible. Bridges and cross-streets govern somewhat similarly on the highway. Very often drainage is a major factor, and by keeping the highway as high as possible, this is much improved.

Therefore an obvious solution to the problem is the use of centre columns. The above span of seventy feet would be cut to approximately thirty-seven to forty-one feet, depending on the width of the centre island. This new span is not too large for a deck structure with railroad loading, when the primary consideration is floor depth. Very often a deck bridge is built that has little more floor depth than a through bridge would have. Rolled beams may also be used sometimes, thus affording a saving in steel.

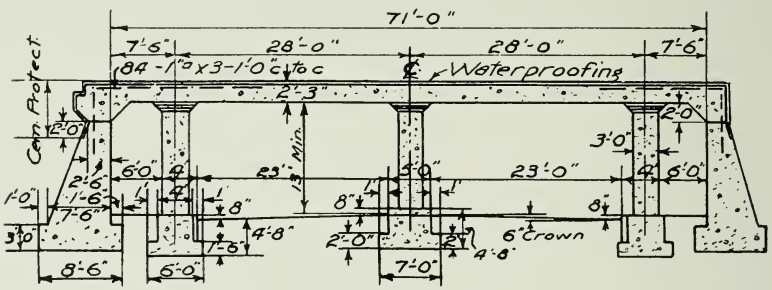



Figure-1

CROSS-SECTION OF A GIRDERLESS FLAT-SLAB BRIDGE (ELMIRA, N.Y.)

### Through Bridges and the Use of Centre Columns

Generally, there is not much saving in splitting up the span length of a through bridge. An economical floor depth for a through bridge of ninety feet is not much greater than that of a sixty-foot one, say. Therefore, changing the profile of either railroad or highway is not warranted. The girders of the former are slightly farther apart, giving a longer floor beam span and theoretically increasing the floor depth slightly, but practically, both the depth and weight per foot of the floor system of one should very nearly equal those of the other. The girders or trusses are directly benefited by the cut in span length. The length of the two shorter spans, in some cases, only exceeds that of the single span by the centre island width. Hence there will be a large saving in girder weight.

This saving is offset by the fact that there is additional work to be carried out, viz., the centre columns with their footing, curbs and the widening of the roadway, entailing extra pavement, grading and land. There is also the question in the case of long spans as to whether or not the addition of sidewalk columns will prove economical; but generally, with this combination, a deck structure is the most desirable and feasible type. Sometimes where there are exceptionally long spans due to an unusually large angle of skew, a through bridge type is the only possible one. However, in such a case, if a moderate increase in floor depth is permissible, a deck structure is desirable (the grade of either railroad or highway must then be greater than that provided by plans of a through type).

One bad feature of a through bridge is that in installing future tracks, the bridge has to be either altered, or the tracks spread and a new structure built alongside of the old one.

## Reinforced Concrete Structures

Reinforced concrete has been used for years for grade separation structures, but only for short-span bridges. Since the design was usually a simple span slab reinforced for tension, spans of over twenty feet caused excessive slab depth; but at present, the design of grade separation structures is progressing rapidly. The object is to reduce the thickness of the slab so that grading which is usually dependent on floor thickness, may be reduced. Within the last two or three years, a number of reinforced concrete structures have been designed for grade separation showing much ingenuity and affording much economy.

### *The Flat or Four-way Slab*

The flat or four-way slab is most common where inconvenience to traffic is not so important. The girderless flat slab is only a recent innovation as previously it was used in building work. It is an ideal type for wide bridges carrying four or more tracks, because there is no obstruction between tracks and thereby obviates the necessity for widened track centres. The bearing capacity of the soil sometimes determines the desirability of using this type. The four-way or flat slab results in an almost 50 per cent. reduction in the thickness of the dead load slab, resulting in a large reduction of soil pressure. Therefore, it is often advisable to use that type of bridge where the soil pressure is low. In addition the four-way system is much more adaptable to uneven settlement or uneven distribution of load on the footing. Not only is the flat slab bridge very economical, but with the square drop panels and round columns, the aesthetic side is very satisfactory.

On the question of grades the use of the girderless flat slab bridge with columns on the centre line results in a reduction of required floor depth of from one foot to one and a half feet, which can be used in reducing the approach grades. A good example of this was the use of a girderless flat slab bridge at Elmira, N.Y. (Fig. 1). The

Through bridge structure. Note the large angle of skew necessitating a truss span. Note also the unusual length of the underpass and the massive centre piers. (King St. W., Toronto)

Rigid-frame, reinforced concrete structure. (St. Clair Ave., Toronto)

columns were 28 feet centre to centre. A one-way reinforced slab continuous over supports would have had to be three and a half feet deep, whereas a four-way slab required only a slab thickness of two and a quarter feet. The depth of street depression was limited by street sewers and each additional inch raise of track meant approximately 6,000 cu. yds. of additional fill. Not only did this reduction in slab thickness reduce the amount of fill required by almost 100,000 cu. yds., but also shortened the yard area affected by 400 feet.

*The Problem of Sidewalks*

The sidewalks through grade separation structures are an important problem. Where the street is depressed, it is good practice to raise the sidewalks to a minimum overhead clearance of eight feet. This not only improves the sidewalk grade but also allows space below it for pipes and conduits. However, there is the danger of the walls supporting such sidewalks to bulge and fail, due to overturning tendency. This is overcome by anchoring them firmly to the abutments and placing the walk slab on top, or pouring the sidewalk wall and the floor of the conduit space as portions of the abutment. In this case, the reinforced top slab forms the sidewalk. An added advantage is that the bases of the abutment may be spread forward under the walks, instead of to the rear, thus saving in the amount of excavation required, without at the same time reducing the effective width of the underpass. (Fig. 4.)

## Most Recent Developments in Grade Separation Structures

In the last two or three years, the Canadian National Railways has built a number of unusual but highly satisfactory types of grade separation structures. Outstanding features include unusually long spans with shallow slabs of precast reinforced concrete, rigid-frame type of construction, and a radical departure from the usual type of ballasted deck structure.

*Rigid-frame Type*

The rigid-frame type of bridge is very common in highway bridges, but for bridges with railway loading it is rather uncommon. A special feature is that the span and abutments are cast monolithic (without going into detail). This causes a substantial decrease in the effective depth of the slab, while the spans may be made exceptionally long. (Fig. 2.)

This type has several distinct advantages. It is an ideal type for urban location where the aesthetic properties are necessary. There is an appreciable saving in headroom and it is economical to construct. It can also be constructed under traffic (if more than one track is on structure).

*Long Precast Bridge Slabs*

When single-track grade separation bridges are built under traffic, precast reinforced deck slabs are being used. Essentially,

this type consists of two (usually) precast reinforced flat slabs placed side by side, interlocking longitudinally and carried over a pier in the centre of the street. The overall length of such slabs runs as high as 61 feet.

Great care is taken in manufacturing these slabs and special forms at track level are usually used to cast them as near the point of erection as possible. The reinforcement is for both tension and compression and high strength concrete is used so that the depth is substantially reduced. They are so placed that each slab takes the loading from one rail. (Fig. 3.)

This type is advantageous in that it may be built under traffic and while quite simple in design, nevertheless is very pleasing in appearance.

## Deck Ballast and its Most Recent Developments

Generally, the track layout is as follows:—The more recent types of structure have a reinforced concrete deck waterproofed with suitable asphaltic cloth or similar material and then one and a

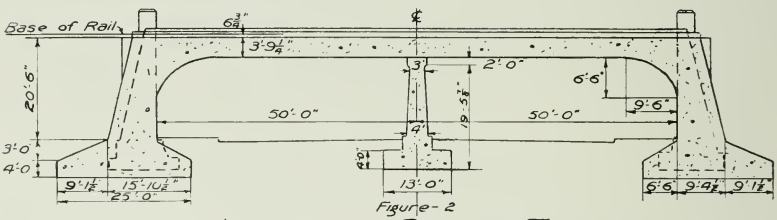



Figure-2

LONGITUDINAL SECTION THROUGH RIGID-FRAME TYPE OF STRUCTURE (ST. CLAIR AVE., TORONTO)

half-inch or two-inch asphaltic blocks or planks. These latter are to protect the waterproofing from abrasion by the ballast, which comes next. The ballast is usually seven to ten inches thick and the ties and tracks are placed on this. It can thus be seen that there is an appreciable distance from the deck structure to the top of the rails. This naturally causes either additional track raisage or street depression.

There have been remarkable changes in ballasting tracks on grade separation structures. On the latest types, there is no ballast at all. The track structure consists essentially of concrete ties resting directly on the deck slab. (Fig. 4.) These ties vary in size from 6″ reinforced ties to 8″. The tracks rest on hardwood cushion strips, which are seated in grooves $5\frac{3}{4}'' \times \frac{7}{8}''$ deep, in the upper faces of the ties. The rails are secured to the ties by means of special clips, held in place by three-quarter inch bolts, which pass through the clips and into internally-threaded pipe sleeves embedded in the concrete of the ties. Four holding sleeves are provided at each rail seat, each being $4\frac{3}{4}$ inches long and anchored in the concrete by means of a steel pin passed horizontally through them below the

lowest possible travel of the rail-fastening bolts. (Fig. 3.) In construction, once the ties and tracks are lined up properly, the entire area of the deck between ties is poured with concrete to the top of the ties to anchor them in place permanently.

On several structures there are neither ballast nor ties. The rails are laid directly on creosoted oak cushion strips set in a groove of about $5\frac{3}{4}$ inches wide by $\frac{1}{2}$-inch deep in the deck slab. (Fig. 3.) The rails are held in place identically as stated above. This method does away with the extra dead weight of the ties and the concrete between them. Principally these features were introduced to minimize the distance from base of rail to the underside of the deck slab, thereby reducing the amount of track raisage or street depression. There will also be a minimum of maintenance necessary. This is the most recent development of track structure and is certainly a radical change.

## Construction Methods

The time element is a major factor in grade separation work. This has influenced the design of structures chiefly through the methods of construction and the use of materials and units, which may be most promptly formed and placed, either for temporary bridges to carry street and railway traffic, or for permanent bridges, retaining walls, sidewalks, etc., that finally replace the level crossing.

### *Outline of Various Methods*

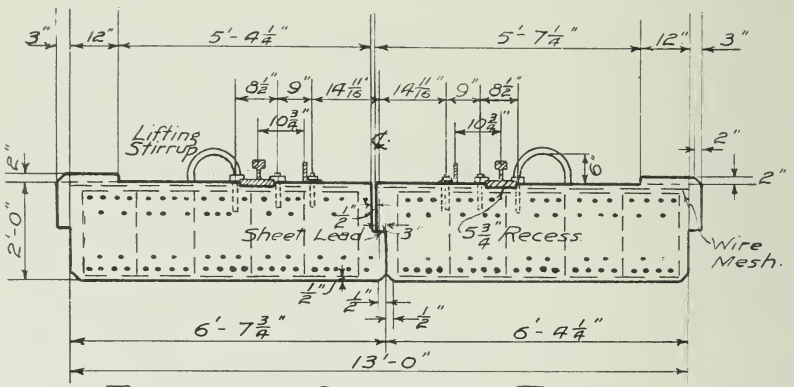
Sometimes it may be possible to shift or detour the main tracks to one or both sides of the right-of-way, and in this manner to allow the central part to be used for the construction work. Then the traffic may often be put on the new grade, one track at a time, and the remainder of the work carried out. Another method is to take one or more tracks out of service and erect a temporary construction trestle at or above the new permanent grade. (These trestles have grades varying usually from $1\frac{1}{2}\%$ to $2\frac{1}{2}\%$.) Then the abutments on either side of the street intersections are built, fill is dumped in between them and widened out by side filling from the new elevation. Instead of temporary trestles and dump cars, motor dump trucks and plank roads may be used to place the embankment. This method obviates the construction of filling trestles and the use of tracks by grading trains. It also permits a wide latitude in the scheduling of deliveries, both as to location and quantity. Some recent grade separation schemes in places such as Valley Field, Long Island; Elmira, N.Y.; and Birmingham, Ala., have used dump trucks to decided advantage.

Another successful construction plan is to place the filling material in the embankment by clam-shell derricks or locomotive cranes from flat-bottom cars. In this way sufficient material can be handled to make the dump wide enough for one or more tracks. Then the widening is completed by moving the tracks and continuing to unload from the high level by clam. This latter method

is advantageous in that the cars can be moved and all classes of track and bridge material can be handled by the locomotive cranes.

*The Use of Schedule Plans*

The most economic method of construction is arrived at only by studying the conditions peculiar to each individual project. To make such a study easier, small scale plans showing the stages of construction are very useful and so necessary that they should be given full consideration before the adoption of the design. Such plans show the alignment, typical cross-sections at all critical points for each stage of the construction, and track profile. If they are properly made they are invaluable to the engineer. The contractor also can make a closer estimate of the cost of the work with this




TRANSVERSE CROSS-SECTION THROUGH CENTRE OF PRECAST SLAB (SHERBROOKE, QUE.)

Fig.-3.

information available. A carefully prepared schedule is likewise made so that adequate provision for handling both railway and motor traffic at all times is assured. City authorities often object to very much interference with existing traffic. Therefore, the construction work is so scheduled that one grade separation is completed before another is commenced (if more than one crossing is involved). It must be remembered that there must be as little inconvenience as possible to traffic. Trestle bridges may be necessary to carry motor traffic over the construction work or new temporary level crossing may have to be established.

## The Division of Costs

The costs of any grade separation project may be defined to be those of construction, the capitalized additional expense of maintenance after construction, and property damages. It may be said that the total costs of one project in dollars per cu. yard of earth

or concrete or per ton of metal at a given time are not indicative of similar costs on another project at another location and time. Costs in terms of man and machine hours are more generally applicable.

In some instances in the past the railroad had to pay all the expenses of the project; but this position could not be maintained. As it is now, the railroad still pays a goodly portion of the costs as shown by these figures:—

Railroads—35 to 50% of the costs.
Municipalities—35 to 40%.
Government grade crossing fund—15 to 25%.

Many engineers (and, of course, railroad officials) feel that this apportioning is most unfair.

At the present time, the cost is divided among the benefiting parties, viz., the railroad, the municipalities, and other interested concerns such as street railways, industries, state, and other public bodies. In the recent elimination at Birmingham, Ala., the rail-

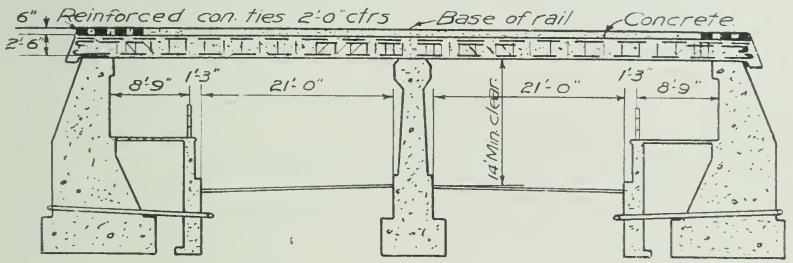



Figure-4
LONGITUDINAL SECTION THROUGH BRIDGE SHOWING GENERAL DETAILS
(RICHMOND ST, LONDON.)

roads and the city each paid half of the cost of the work on its own property. In such apportioning, it should be remembered that the work involves a public benefit and is not merely a railroad improvement.

"The burden of these expenditures must be borne by the public in one way or another, but the question arises whether this burden is being apportioned fairly. To the extent that it is caused by other than railroad needs and does not increase the traffic of the railroad or save them expense, it may be that this burden should be justly shifted from the shoulders of the railroad users".* The crux of the present difficulty in grade separation is in financing this work on a basis that is thoroughly sound and fair to the railroad and to the public. It is vital to the public because the public has to pay, either in the form of governmental revenue on the one hand or through transportation rates and decreased returns on its investment in railroad securities when the undue burden is imposed on the railroad.

*Interstate Commerce Commission, U.S.A.

Many efforts have been made to develop a formula to determine the relative benefits of grade separation to the railroad, and to the public. In such a manner the relative costs could be arrived at; but it is the general opinion of engineers that on account of the many variable conditions and the difficulty of expressing benefits in terms of money, that no formula is feasible.

The division of costs of such projects is determined by the Board of Railway Commissioners of Canada. This body has very wide powers and can order the separation of grades at highway crossings or take such action in the interests of the public as it deems expedient. It is best suited to determine the costs in that it is a disinterested public body, given quasi-judicial authority, hearing evidence and deciding impartially the relative benefits of the grade separation work.

Of course the Board's judgment is not always infallible and there might be room for argument, but since the railroads' share has declined somewhat in the last few years, it seems that steps are being taken in the right direction to improve matters. However, many people still think that the railroads have to pay a very unfair portion of the costs.

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# STEAM TURBINES FOR HIGH PRESSURES AND TEMPERATURES

*Condensed from a Thesis for the Degree of B.A.Sc. in Mechanical Engineering*

BY J. A. McCUAIG

The subject of this paper is vast and places many varied problems before the present-day mechanical engineer. Stupendous progress has been made in steam turbine development during comparatively recent times, this development embracing a period of from fifteen to twenty years. In the immediate future great strides forward are expected toward better design and operating conditions governing this type of prime mover. It is the author's intention in this paper to bring forth data on modern installations, dealing mainly with turbines of the size and type required for larger central power stations.

The steam turbine has laid very definite hold on the central station field on this continent, in England and in Europe. A volume published in 1907, devoted to the theory and practice of the steam turbine, contains the statement, taken from a paper published the previous year as follows: "There can be no doubt as to the status of the turbine as a prime mover, in the generation of electricity by steam, for all of the recently designed stations which were visited were equipped with turbines and some of the older stations, built originally for engine driven units, are being increased in capacity by the installation of turbine units. . . . It is rather interesting to note that in the interviews with leading engineers no question was ever raised as to the comparative merits of engines and turbines for electric light plants." A statement such as this, apparently representative of the prevailing school of thought and conditions at the time of publishing, together with the strides made in the development of the turbine and its use since that time, gives some conception of the importance of the turbine in the field of power generation. Still, turbine plant practice has not reached its state of perfection and four desirable objectives remain to be attained:

1. Improvement in reliability in order that generating capacity may, to the maximum extent possible, be available for service when needed.
2. Reduction in fuel consumption per kilowatt-hour of net station output.
3. Reduction in the overall investment per kilowatt of system peak load carried.
4. Reduction in cost of operating labour and maintenance.

TABLE 1. AVERAGE PERFORMANCE OF UNITS 20000 KW CAPACITY AND LARGER

| | 1914-1921 | 1923 | 1926 | 1928 | 1930 | 1931 |
|---|---|---|---|---|---|---|
| Turbine units reviewed .... | 78 | 87 | 153 | 207 | 324 | 334 |
| Turbine outage factor % ... | 6.93 | 7.33 | 6.28 | 5.73 | 4.44 | 4.20 |
| Service hours factor % .... | 66.50 | 72.40 | 67.06 | 68.58 | 62.96 | 57.93 |

The above table shows fairly accurately the success met with in the pursuit of these objectives during the period 1914 to 1931. The number of units reviewed each year shows a steady increase, indicating the growing popularity of the turbine in connection with power generation.

In Great Britain the developments in steam turbine practice during recent years have been influenced largely by the National Electricity Scheme, which provides for the eventual linking of all power stations in the country by an interconnecting network of transmission lines, known as the "grid". In this plan is also included the erection and equipment of a number of new large central generating stations, extension of the better existing stations and the scrapping of a great number of small and inefficient stations.

To equip the new central stations, units, large in comparison with previously considered economical sizes, are required. A number of units are now in operation or under construction ranging in capacity from 50,000 to 75,000 kw. In cases of extension to existing stations units of from 15,000 to 40,000 kw. capacity are usually required.

English practice is definitely in favour of single-line units and all the plants now being installed are of this type. The size of the unit in relation to the normal station output is so chosen that no necessity arises for operating one section of a machine independently of another, a provision usually necessary when large cross-compound units are installed.

Multi-cylinder machines are general for both impulse and reaction turbines. The principle that a large number of stages with moderate steam speeds are essential for high efficiency has long been known, but in the past has been ignored in impulse turbine design, where the employment of partial admission encouraged the use of large wheels at the high pressure end. The manufacturers of impulse turbines have now turned toward many-stage machines. Other essentials for efficiency are fine diaphragm and blade clearances, necessitating short, stiff rotors and imposing a limit on the number of wheels per cylinder. In order to efficiently utilize the heat drop available with higher steam temperatures now in use either two- or three-cylinder designs are nearly always used.

High thermal efficiency has necessitated provision of large blade areas at the exhaust end to lower the leaving losses. Doubtlessly this has been an influence on rotational speeds, as up to the present single-line units of 40,000 kw. and upward are designed for 1500 r.p.m. Several 30,000 kw. plants operating at 3,000 r.p.m. with double-flow low-pressure elements are in operation and since the units can be built for much larger outputs an extension at this stage of size and speed is to be expected due to reduction in the manufacturing cost of the turbines. Lower investment per unit of installed capacity in the turbine generator itself and in the related equipment and structures, slightly lower fuel consumption, and lower costs for operating labour and maintenance per unit of station output are reasons for the adoption of larger units. In metro-

politan areas the desire to install the maximum possible capacity per square foot of expensive real estate has been a controlling reason for the use of larger units.

In the larger central-station plants now under construction a steam pressure of 600 to 650 lb. per sq. in. is generally adopted. This applies whether or not reheating is employed and indicates the uniformity of opinion amongst designers. Up to 600 lb. the theoretical cycle efficiency is increasing fairly rapidly with the pressure, but above this the curve becomes relatively flat. Between 600 and 1,200 lb. the pressures possess the limitations of the higher level and the potential saving is too small to justify their adoption on the score of efficiency. These pressures are found only in special cases where special conditions necessitated their adoption. The graphs shown in Figs. 1 and 2 show the trend of steam pressures and temperatures.

The cross-hatched areas show the limits within which representative steam-station practice has fallen. The curve drawn through the hatched areas attempts to indicate the trend or conservative practice. The horizontal lines extending from 1928 to 1932 in both figures indicate the views of several schools of thought as to the best steam pressure and temperature. Among English engineers there seems to be a definite preference for the 600-lb. level. Much importance is attached to securing the highest possible internal efficiency of each individual part of the plant, and this is regarded as the best method of obtaining good overall performance; involving less capital expenditure than the adoption of higher pressure.

Considering the history of the adoption of high pressures in Europe it will be found that de Laval was the pioneer. As early as 1897, he made a boiler and turbine for no less than 2,800 lb. per sq. in. and temperature of 700 deg. F. The purpose was for power supply at the Stockholm Exhibition. De Laval has also made more recent turbines for high pressures. They are small back pressure turbines for about 500 kw. with steam at 1,400 lb. per sq. in. at 750 deg. F. Naturally, for this range of output, a turbine for high pressures will only be justified as a back pressure machine because then it may work at a poor efficiency but with little effect on the overall efficiency of the plant. The entire heat drop is employed in two single-row impulse stages, overhung at the end of the shaft. The turbine speed is 15,000 r.p.m.

The first applications in Europe of very high pressures on a large scale were made at the Langerbrugge Power Station in Belgium. Before the pressure was raised, all the turbines in the station were for 285 lb. per sq. in. gauge. The primary turbine built by the Brown, Boveri and Company works between the high pressure boilers for 710 lb. per sq. in. gauge, and 830 deg. F. and the old steam main.

The definition of steam turbines for high pressures may logically be extended to include turbines which have been made as experiments for very high temperatures, the pressure, however, being

only moderate. The most outstanding example of a turbine of this type is the British Thomson-Houston machine for the Delray Station at Detroit. This turbine expands steam from about 370 lb. per sq. in. gauge at 1,000 deg. F. down to .5 lb. per sq. in. absolute without any reheating. It has two cylinders and the steam flow is about 90,000 lb. per hour. In order to reduce the radiation losses of the hot steam mains, separate oil-fired superheaters are placed close to the turbine. The plant must be considered chiefly as an experiment and for this reason the principal aim was to achieve reliable operation rather than high efficiency.

## Some Details of Design

### *Blade Materials*

The corrosion of the blading, which was a frequent cause of turbine troubles a few years ago, is no longer a source of anxiety to the operating engineer. This is due primarily to the development of the so-called stainless steels. Refinements in feed-water equipment in the present-day power station have raised the standard of purity for the feed and it is very seldom that the steam contains any appreciable quantity of materials likely to cause serious corrosion of modern materials. The most useful grade of stainless steel is that known in the trade as stainless iron. It is to be preferred to the higher-carbon stainless steels because it is freer from the danger of becoming brittle due to air hardening during manufacture. Its properties are such that it is suitable for the higher-stressed low-pressure blading, at least up to tip speeds of 1,050 f.p.s., and it gives equally good results at the high-temperature end of the turbine.

Stainless iron is not suitable where salt is present in the steam as it is not highly resistant to chlorides. In cases where it is not possible at all times to prevent some chloride being carried over by the steam the only solution of the problem is the use of more costly blade materials. Either austenitic steels or non ferrous alloys such as monel metal may be used. It is, however, essential to take all possible steps to avoid the presence of chlorides, as even if a resistive metal is used for the blading, the problem of corrosion to other parts, such as valve spindles, gland journals and cylinder bores, still remains.

### *Erosion*

Much difficulty has resulted in the past from a failure to distinguish properly between erosion and corrosion. "Erosion" means wastage by a purely mechanical action—by disintegration of the blade surface into minute particles, without any chemical change.

The final row of blades are eaten away by this impingement at high velocities on almost stationary water particles. A machine operating at a pressure of 450 lb. per sq. in. with a total steam temperature of 750 deg. F., and exhausting to a vacuum of 29 inches of mercury, will have approximately 10 per cent. of the total

fluid passing through the last row in the form of water, unless reheating or some form of drainage is adopted. These conditions coupled with really high blade-tip speeds form a very serious problem which has been taxing the turbine designer's ingenuity to the utmost. Erosion increases very rapidly with increase of blade speed, and while a tip speed of 800 ft. per sec. may not call for any special precautions, on reaching 1,000 ft. per sec. a drastic remedy is demanded.

Erosion is most rapid in the first few hours of running and may be quite alarming, but the action soon slows down and for present-day conditions a blade life of about five years continuous running should be obtained. Higher steam pressures and blade speeds necessitate the application of a preventative which may take the form of an attempt to drain the water particles or provision of special blading material which resists erosion to a greater degree than mild steel or stainless iron etc. Many methods of draining have been applied by various turbine manufacturers with varying degrees of success.

A form of drainage belt arranged to trap as much as possible of the water accumulated on the casing is shown in Fig. 5. This belt is connected to a small feed heater, through which a portion of the condensate is passed in parallel with the ejector condensers. This facilitates the withdrawal of the water by creating an applicable outward flow of steam through the port. It will also be noted that the tips of the rotor blades in the preceeding row fractionally overlap the metal of the casing. The layer of water flowing from the casing bore into the mouth of the belt acts as a seal to prevent steam leakage.

The preventative for erosion once having been found, blade speeds will probably increase, and this will entail the use of very high-grade alloy steels for the final moving blades and discs, whilst the turbine designer will look to the steel-makers and forge masters to accept even more stringent conditions than the already onerous specification with which they have now to comply.

*Cylinder Construction*

The design of high pressure cylinders resolves itself mainly into a question of reducing to a minimum the strains and distortions which result from temperature inequalities. With this end in view, a design has been adopted which aims at providing a rigid and symmetrical tubular core which will attain a sensibly uniform temperature across transverse sections, and will under all conditions dominate the shape of the structure. The steam inlets, feed-heating ports and so forth are arranged as flexible belts which, where their natural expansion differs from that of the main core, can accommodate themselves without introducing appreciable constraints.

The cylinder-joint bolts are heated to tighten them up and this practice has the advantage that clearance for a heavy spanner is no longer required. The bolts may be pitched closer together and they also can be tightened to an equal and determinate stress.

Electrical heating methods are employed and are used both for closing in and opening out the turbine. Since there is no pressure on the thread when the nut is turned it has been found very useful in reducing the seizing of nuts which used to cause so much trouble when machines were opened out after prolonged running on high temperature steam. Spraying the threads of all bolts with alum-

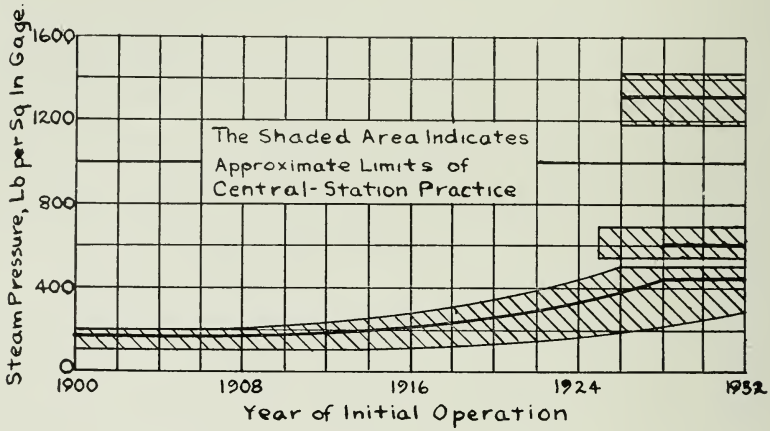


Fig. 1. Increase in Steam Pressure.

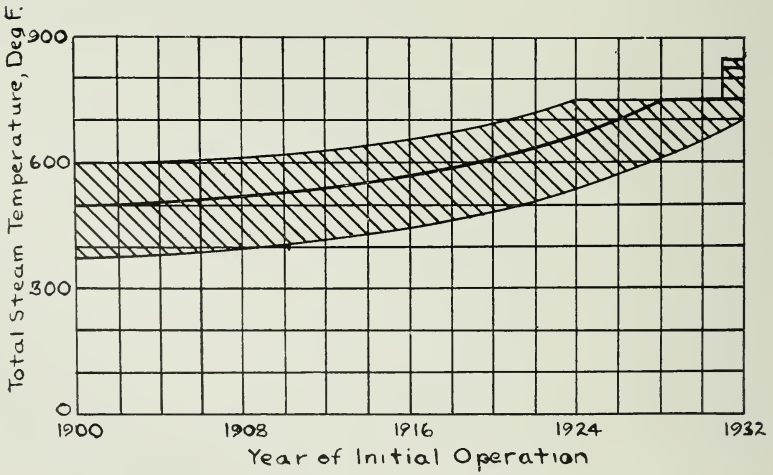


Fig. 2. Increase in Steam Temperature.

inium has been found to be a further effective precaution against seizing. The aluminium appears to protect the surface of the steel from oxidation, and though an oxide film probably forms on the aluminium, this can be sheared comparatively easily when it is desired to slacken the bolt.

*Valve Gear*

Governor valve design is a matter of some importance. At high velocities the momentum of the steam passing through the valve is very large, particularly when the steam pressure, and consequently the density, is high. If this momentum is altered by contact with some part of the valve away from the seat, considerable out of balance forces are produced on the valve. As these forces depend on the weight of steam passing and on its velocity through the valve seat, their magnitude varies considerably with the load, being in general greatest at about half-load. They fall off at higher loads, although the weight of steam is increasing, because the velocity is falling rapidly. These rather indeterminate forces may cause unstable governing, chatter of the valves and as a consequence excessive wear and sometimes actual fracture of the spindles. A form of valve such as the profile double-plate type has been evolved to eliminate, as far as possible, forces such as the above.

The curved profiles adjacent to the seat have the advantage that the ratio of effective area to valve lift increases continuously as the valve opens, a feature which assists in maintaining a constant sensitivity of governing at all loads.

"Valve whistle" is another interesting problem in connection with governor valves. There have been cases in which the steam passing through the valve has produced a high pitched screech. This has occurred only over a restricted range of valve travel and is produced by the high-velocity steam jet from the valve impinging on the edge of some part of the seating or chest. The exact point where the screech is produced is difficult to locate but it is effectively silenced by an alteration to the valve profile.

In the case of reheat units, control of the steam stored in the reheater is effected by the provision of valve chests at the inlet to the low pressure turbine. The valves are controlled by a centrifugal governor independent of the main governor, and are arranged to be normally full open, but to respond very quickly to the governor if the turbine speed reaches 5 per cent. above normal. This avoids the danger of the machine tripping out on over speed due to the reheater capacity.

*Turning Gear*

The practice of providing large machines with motor-driven turning gears is now general. These are necessary due to the fact that the cooling of a stationary machine after shutting down does not proceed evenly. As the heat stored in the hot end of the spindle gradually soaks through into the colder end, the average temperature of the top portion tends to rise above that of the bottom portion. The greater the initial temperature gradient and the more massive the shaft, the more pronounced does this effect become. Large shafts may be sufficiently bowed to throw them out of balance due to this phenomenon. This distortion may persist for several hours, and during this period difficulty may

be experienced in getting the machine up to speed without objectionable vibration. Owing to the time taken for temperature distribution to adjust itself, vibration may persist for some time after the machine has been put on load. If the shaft is turned slowly the cooling is controlled, a symmetrical flow of heat takes place and the shaft has no longer a tendency to distort.

To achieve this result it is unnecessary to keep the shaft turning continuously, it is sufficient to turn it at intervals, perhaps once an hour, through a portion of a revolution, so that the same influences which produce a distortion during one interval tend to correct it in another. It is necessary to provide a high-pressure oil system connected to the bearings in order to overcome the starting friction of a dry bearing. This pressure system can be

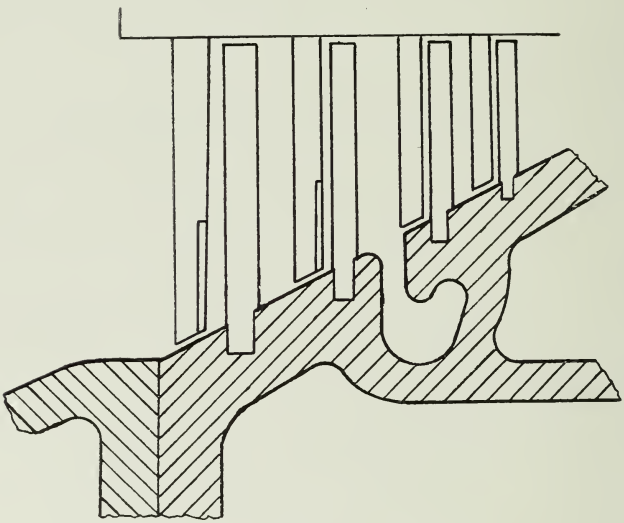

Fig. 5

used to lift the journal off the bearing and to establish an oil film before the turning-gear motor is switched in. Oil pressures of 1,000 to 1,200 lb. per sq. in. are usual for this purpose, supplied from a small motor-driven, multi-throw plunger pump.

Apart from the turning of the shaft during a temporary shutdown, the turning gear has another use, of particular importance to machines operating with very high-temperature steam and that is to simplify the process of starting up from cold. The continuous type of turning gear is necessary for this purpose. It is essential when starting a cold machine to have the spindle rotating during the warming up period, otherwise unequal heating of the spindle is almost unavoidable. If the turbine is started from rest by steam, a large amount of hot steam must be passed suddenly into the turbine and the cold cylinder and valve chests are subjected

to very severe temperature shocks. If, however, the turning gear is utilized to turn the spindle, only enough steam need be admitted to warm up the plant gradually and uniformly.

With regard to other parts in turbines for higher pressures, it has been found that for present day conditions, or for pressures not exceeding 2,800 lb. per sq. in., there is no necessity for any new details differing essentially from those employed in turbines for ordinary pressures. The rotors have usually many stages of small diameter and are often cut from the solid. Owing to the small volume of the steam, impulse blading is more frequently used than reaction blading. It is even possible to retain the ordinary designs of glands, the type in three concentric parts employed by the American General Electric Company being no exception to this rule since it is also used for moderate steam pressures and temperatures. It is only for pipes, valves and other fittings in the live steam main that it has been necessary to devise new methods, only two of which will be mentioned here. These are both practical applications of welding, an operation which has recently been acquiring popularity as a method of manufacture. The seats of valves for live steam used to be made, generally, of pure nickel and were pressed into the cage or valve. They are now manufactured from a nickel-chromium steel belonging to the austenitic steel series, and they may be welded to the valve satisfactorily. The welding of pipe joints for live steam is of even greater importance. When it is difficult to obtain tight joints with flanges an obvious thing to do is to weld the pipes together. Applications of this method have proved quite successful up to the present, but pipes which have been joined in this way can only be separated by an oxy-acetylene blow torch. For this reason it may seem better to make joints which can be broken and to continue using flanges. These should, however, be welded to the pipe. It has been found by experience that it is possible to produce perfect joints without difficulty and no decrease in strength is apparent either in the weld itself or in the neighbouring material. Apart from welding, joints in high pressure steam pipes may be made successfully with flanges which are either screwed, rolled or riveted to the pipes. Long experience only will disclose which method is the best.

The phenomenon known as "creep" has become an important factor in design since the adoption of high pressures and temperatures. Investigations made during the last ten years on creep of steel at high temperatures have forced designers to the conclusion that the old methods of stress analysis are wrong in principle because they are based on Hooke's Law. Experience has shown Hooke's Law to be not applicable at high temperatures. It applies mainly during a short initial period of use and is very modified during later stages.

This is due to the fact that steel, when submitted to stress at high temperatures continues to extend very slowly beyond the initial elastic extension which occurs immediately the load is

applied. This low and continuous extension called "creep" increases with the stress and temperature to which the material is subjected. If stresses are not uniformly distributed throughout the structural element, higher stressed portions tend to creep at a greater rate and in time the material will become uniformly stressed if the stresses are above the true creep limit.

Recent experiments have proved that a material may have a creep of less than $10^{-8}$, that is, one millionth part of its length in 100 hours at stresses much below those previously assigned as "creep limit". This points to the fact that true creep limit does not exist.

The permissible stress for any part will depend on the time taken by the material to creep to an extent equal to the elastic deformation under the stress applied. This time may be calculated by the following equation:

$$\frac{f}{E} = C \times T$$ where, f = stress on the material

E = modulus of elasticity at the given temperature

C = rate of creep at the stress and given temperature

T = elastic strain creep time.

From this equation the allowable creep rates for various parts in a steam plant may be found, these are:

| | |
|---|---|
| Turbine discs pressed on shafts | $10^{-9}$ |
| Bolted flanges, turbine cylinders | $10^{-8}$ |
| Steam piping, welded joints, boiler tubes | $10^{-7}$ |
| Superheater tubes | $10^{-6}$ |

These creep rates are of course dependent on the fact that the stresses must be well below the yield point of the material at the temperature of operation.

Attempts to apply high pressures to other than stationary units are few in number. In ships the highest pressure used up to the present is not more than 500 lb. per sq. in. Experimental locomotives for high pressures up to 1,700 lb. per sq. in. having reciprocating engines or turbines have been designed or are under construction. Mr. H. N. Gresley published a paper in the Proceedings of the Institution of Mechanical Engineers, January 1931, on installations of this type.

Constructional differences between American and Continental practice are becoming evident with the continued use of higher steam pressures. Manufacturers in America seem to favour the two-cylinder machines which may be of the tandem or cross-compound type, while several prominent Continental firms are adopting three- or four-cylinder in-line sets with a single alternator. American practice, however, is generally to increase the steam pressure and keep the total temperature at 750 deg. F., while the more recent Continental designs go to 850 deg. F. and above, in conjunction with higher pressures.

Much can be said in favour of the use of several cylinders, as short stiff shafts of relatively low weight tend towards flexibility in operation. On the other hand, overall length is increased and interconnecting pipe losses are introduced. Resuperheating favours the use of three-cylinder design for outputs approaching the limit at a given speed.

At present the trend in steam turbine practice shows an adoption of higher pressures and temperatures than heretofore used, an increase in output and speed, all of which conditions combine to produce problems in the selection of appropriate materials and safe stresses. The many complicated methods of governing mixed-pressure and extraction turbines and the endeavour to obtain the optimum efficiency with a minimum of material, all the above are problems requiring long and detailed study. As with other precision machines, high efficiency turbines demand the most careful attention to design details, most accurate workmanship and the best of materials. Considering the size of some of the recent installations it is easy to realize that errors in design or manufacture are apt to prove costly.

It is quite true that an unprecedented development has taken place in steam turbine design during the last fifteen or twenty years and that this development has had an enormous influence on power production, capacities of power stations rising to immense proportions. Still developments proceed and the competitive struggle for heat efficiency is not yet over and many further developments are to be expected within the next few years. All efforts are directed toward the same end which is summed up quite concisely in the following statement: "The most reliable and economic prime mover." Thus the same object, the same considerations and experiences the world over are leading toward a standardization of form and it is inevitable that variations in the designs of steam turbines must diminish as the solution of this definitely specified problem is approached.

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# ANTI-KNOCK GASOLINE AND ITS RELATION TO HIGH COMPRESSION MOTORS

*Adapted from an address by W. M. Turnley of the Ethyl Gasoline Corporation, Toronto, to University of Toronto Engineering Society, January 8, 1934.*

Today the anti-knock value of gasoline is perhaps its most important quality and it is of interest to follow the early history of the finding of fuel knock.

When the 1912 Cadillac began to knock no one knew what knock was or what caused it. It was natural to blame it on the latest addition to the motor, which was battery ignition, and if battery ignition was to be saved, someone had to show that it was not responsible for this thing called "spark knock". It was up to Mr. Chas. F. Kettering, the inventor of battery ignition, so in 1914 he started to look for knock and what caused it.

To follow Mr. Kettering's reasoning we must have an understanding of the expression used to designate the amount of pressure resulting from the squeezing of the gasoline vapor which is "compression pressure", but since this is the result of many factors, automobile men generally consider the pressure roughly by measuring the volume of the cylinder before compression and the volume after compression. If the volume is five times as large at the beginning as at the end of the compression cycle they say the engine has a compression ratio of 5 to 1.

The piston rising, compresses the gasoline and air mixture, the force needed for this being supplied from the crank shaft. Somewhere near the end of the stroke, usually before the limit of top dead center is reached, the spark plug gives an electrical flash that ignites the charge. If gasoline and air vapor burned instantaneously, this would knock the piston right back towards the crank shaft and stall the engine. But it does not burn instantaneously under normal conditions. Inside the cylinder, gasoline and air vapors burn so that the pressure generated by the gases formed does not exert its full force until the piston has passed over top dead center and the power can be used for work on the down stroke.

Possibly it is difficult to understand why gasoline engines give more power when the pressure on the charge before burning is high, than they give when it is low. This is a phenomenon of physics, but it applies to practically all combustible materials whose rate of burning approaches the speed of an explosion. This phenomena is explained by the fact that the pressure increases more rapidly than the volume decreases or in other words, decreasing the volume by half more than doubles the pressure. The

fact we are interested in, is the seemingly magical truth that when the crank shaft spends energy squeezing gasoline vapor before it is burned, it gets back not only the energy spent, but much more when the burning takes place.

These facts were known to Mr. Kettering and his associates when they started the study of "knock". But what was not known was that there was a compression limit inherent in every fuel. This limit is now called "the critical point" and is commonly referred to as the anti-knock rating of a fuel. But at that time all that was known was that high compression pressures were an advantage, that battery ignition was a good way of igniting fuel, but that somehow an engine which had these two characteristics was developing an unexplained "knock".

Before the investigators could do much to correct knock, they had to find out what the knock was, and to do this, special instruments and engines were necessary. You will realize their problem more vividly if you consider for a minute that knocking occurs inside a closed cylinder under conditions of high temperature and high pressure and that the total time of the combustion of gasoline is only a one-hundredth fraction of a second. They first developed an engine containing a quartz window, which enables them to look in and see the difference between the combustion of gasoline under normal conditions and the combustion that caused knock. Looking through this window, it was seen that during normal combustion, the flame was an orange color but that when knock occurred, the flame was white. As you know, a white flame is much hotter than an orange flame, and this accounts in part for the over-heating which invariably accompanies knocking.

Another instrument which they perfected after a long period of painstaking experiments was the visible pressure indicator. This instrument consists of a steel tube screwed directly into the combustion chamber. Inside the tube is a small piston held in place by a spring. Attached to the piston is a rod which projects through the top of the steel tube. A mirror fastened to the end of the rod reflects a beam of light cast upon it. As the rod rises or falls according to the pressure inside the cylinder, this beam of light is thrown up and down. By throwing this light on a photographic film, Midgley and Boyd were able to get an actual picture of the pressure curve inside a cylinder during the split seconds of combustion.

Looking at the graphs produced by this visible indicator gave these pioneers their first real idea of what happens when an engine knocks. Such diagrams under normal combustion show a smooth rise of pressure up the peak point, a rounded peak of high pressure and a smooth decreasing back to normal as the piston delivers its power on the downward stroke. When knocking occurs, the rise of pressure starts out the same way, but at a point near the peak it flies into a series of erratic and extremely high pressures. The graph recovers from this in a series of jagged waverings and then comes back to the curve of normal combustion on the downward

stroke. The natural deduction from this was that a "knock" was a series of very sharp but decreasing explosions. It was not for a long time that they discovered that the oscillations of the indicator were caused by only one sharp smashing jolt of pressure that caused the series of oscillations. If the visible indicator were a perfect instrument, it would show a graph identical to the graph of normal combustion up to the point where knock occurred and then one high jab of pressure for the knock, returning almost instantly to the graph of normal combustion.

This knock is very much like a hammer blow that occurs when gasoline reaches the breaking point. The metallic sound which knocking causes is the impact of the gases striking against the walls of the cylinder. It is hard to realize that gas can strike metal so forcibly that it sounds like metal against metal, but such is the case.

Thus Midgley and Boyd made their first important discovery. They found that knocking was not caused by the peculiarities of the battery ignition or by pre-ignition as some had supposed, but that it was caused by the peculiarities of the fuel itself.

They found that *it is the fuel and not the engine that knocks!*

Then they found that some fuels knock worse than others, and their research narrowed to the task of finding a fuel that would not knock.

So they began to hunt for an entirely new type of knock-suppressor. They searched for some substance which when added to gasoline in some small quantity would give it anti-knock characteristics. They knew that combustion was hotter when knocking occurred than when it was not, because the orange color of the flame seen through the quartz window during normal combustion was obviously cooler than the white flame that accompanied "knocking". They looked around for an ingredient which would give gasoline a darker color, thinking that since dark colors absorb heat this might prevent the "knock".

This led them to iodine which is the violet-red element that is dissolved in alcohol to make the tincture of iodine commonly used for sterilizing cuts. They knew that iodine would dissolve in gasoline, so they added a pinch of iodine to the gasoline and it turned a dark color. Putting this into a motor which knocked on ordinary gasoline, they found that it stopped the knock. That was the second marvelous discovery.

They had found a knock-suppressor. And while iodine was out of the question for commercial use because of its expense and tendency to collect in the motor, they knew that if one chemical could check the tendency to knock, there were probably others which would do the same thing. And so the search began.

Experiments with gasoline containing iodine soon proved that it was the inherent characteristic of the element that suppressed "knocking" rather than the color. This was demonstrated when gasoline containing potassium iodide, which is a colorless compound of iodine, was found to suppress knock, and when a black dye which did not contain iodine at all, was found to have no effect.

One day Thomas Midgley was looking through a chemical catalogue and found there listed an obscure compound which had been manufactured in Germany years before and for which no commercial use was known. It was tetraethyl lead. The price quoted was $585.00 a pound. This compound fitted into the theoretical conditions the investigators had formed from studying the periodic table of elements. It seemed worth trying and they bought a bottle and had it sent over from Germany.

The object of the search was in their hands. Tetraethyl lead opened the way to a knockless motor fuel.

With tetraethyl lead they had opened the gate but there remained the problem of finding a commercial way to make tetraethyl lead cheaply enough so that it would be available to every motorist. Secondly, they must find some compound which would unite with tetraethyl lead at the time of combustion to form a gas and so prevent lead deposits inside the cylinder.

First they undertook the development of a commercial way of preparing tetraethyl lead. Expert chemists of the du Pont Company and of the Massachusetts Institute of Technology were enlisted. After months of intensive research a method was found.

The investigators had believed that this was possible because even though that first pound of tetraethyl lead cost $585.00, they knew that this was a compound of three simple elements—carbon, hydrogen, and lead. These elements are found in abundance on the earth's crust. Two of them, carbon and hydrogen, are the constituents of all gasoline. The other is a relatively inexpensive metal.

Added to gasoline, tetraethyl lead produced the most perfect motor fuel from an anti-knock standpoint the world had ever known. Compared to other ingredients for gasoline which had been found effective in suppressing knock, tetraethyl lead was many times more effective.

Three cubic centimeters of tetraethyl lead give a gallon of gasoline the same anti-knock characteristics as four tenths of a gallon of pure benzol. Tetraethyl lead is, therefore, approximately 450 times as effective per unit volume as benzol. Between these two extremes, other compounds, such as tri-ethyl arsine, aniline, ethyl iodide, tetraethyl tin, diethyl selenide, and diethyl telluride have varying degrees of effectiveness.

Tetraethyl lead is the active ingredient in Ethyl fluid. It controls the rate of combustion of Ethyl Gasoline; preventing the sharp explosions that cause power-waste, harmful "knock" and overheating. Technically, tetraethyl lead is an alcohol of lead. That is, it is four alcohol radicals combined with one atom of lead. It is a colorless liquid about twice as heavy as gasoline.

The second ingredient in Ethyl fluid is ethylene dibromide, also a colorless liquid heavier than gasoline. It is a compound of ethylene and bromine. Ethylene is a gas at normal temperatures, of similar type but of lighter weight than some hydrocarbons which

compose gasoline. Bromine is an element. At normal temperatures, it is a brown viscous liquid more caustic than iodine, but less poisonous than chlorine. Its characteristics are about half way between those of the two above mentioned elements. The purpose of ethylene dibromide in Ethyl fluid is to combine with the lead in tetraethyl lead at the time of combustion to form a vapor which passes out of the engine through the exhaust pipe. Ethylene dichloride has since been added to assist in the action of the bromine compound.

The fourth ingredient in Ethyl fluid is a red dye. It has no effect whatever on the action of Ethyl fluid, nor on the gasoline with which it is mixed. It is used for color only. The distinguishing red color which it gives is an identification of Ethyl Gasoline. The dye used is an organic compound composed principally of carbon and hydrogen, the very elements which form gasoline. It is completely soluble in gasoline and is burned just as gasoline is at the time of combustion.

Freed from the restricting limits of ordinary gasoline, the automobile engine which has been designed to harness its power, now began to take advantage of a stronger and better source of power.

The Ethyl Gasoline Corporation laboratory in Detroit has carried forward much of the research and experimentation necessary to the building of higher compression cars. This laboratory has worked in close touch with automobile manufacturers and has contributed greatly to the improvements that have been made in automotive design between the time the 1924 models were built and today.

In almost every case the tests conducted by engineers of the Ethyl Gasoline Corporation and by automobile makers has proved the practicality of the theories first evolved by the great pioneers, chief among whom was Nicholas August Otto. High compression cars which were built for the race track with a cylinder volume of only 91½ cubic inches developed almost seven times as much power as ordinary low compression engines with a cylinder volume of 177 cubic inches.

For instance, a certain engine with compression ratio of 5.2 to 1, was found to develop a compression pressure before ignition of 104 pounds. Two additional cylinder heads were made for this engine and shaved down so as to reduce the volume ofthe combustion chamber. This gave similar experimental engines of three compression ratios with which tests might be made.

With the head which has been shaved only a little the resulting compression ratio was 6 to 1 and the compression pressure before ignition was 130 pounds. With the cylinder head which had been shaved considerably, compression ratio was 7 to 1 and the compression pressure before ignition was 171 pounds.

By running these three engines connected to a dynamometer, the amount of horsepower produced by each was determined. By looking at the results obtained you may readily see the increased

power produced by increased compression pressure. Running at a speed of 1,000 RPM the 5.2 to 1 compression ratio engine developed only 24 BHP. The 6 to 1 developed 25½ BHP and the 7 to 1 developed 27 BHP. (This is about the speed an engine runs when a car is moving 20 miles an hour). With the engines running at 2,000 RPM respectively, the engine with compression ratio of 5.2 to 1 developed 43 BHP. The 6 to 1 engine developed 46 BHP and the 7 to 1 engine 49 BHP. With the engine running at the rate of 3,000 RPM the difference was even more outstanding. At this speed the engine with a 5.2 to 1 compression ratio developed only 56 BHP, the engine with 6 to 1 compression ratio developed 63 BHP and the engine with a 7 to 1 compression ratio developed 68 BHP.

This gives you some idea of how increasing the compression pressure increases the power output of an engine without increasing the amount of fuel which goes into the cylinder for each explosion, or increasing the size or weight of the engine itself. Other tests with the same three alternate cylinder heads proved just as outstanding an advantage for high compression when considering the temperature of exhuast gases and the amount of heat dissipated to cooling water. In other words when the compression pressure of a given engine is increased, the amount of power developed is greater, the heat which is lost through the exhaust pipe is less, and the work required of the cooling system is less.

High compression can be used to give either one of two things—performance or economy. At the present price of gasoline the public is more interested in performance—but if the price of gasoline should ever become high—high compression can be used for *economy*. This may be done by simply changing the rear end ratio so that every turn of the engine sends the car farther. With the increased power of high compression this is possible without lessening the power delivered to the wheels. A 7 to 1 engine gives much more power than a 5 to 1 engine. If the gear ratios are the same, the 7 to 1 car at the same engine speed delivers more power to the wheels—but if the rear end of the 7 to 1 car is stepped up so that the performance of the two cars is the same, the 7 to 1 car will go much farther on every gallon of gasoline.

What did all these tests mean to the individual car owner? First, they meant that cars could be better at the same cost of operation or equal in performance at a lower cost of operation. But conditions being what they are in America, the performance aspect was much more important at the present time. Automobile manufacturers took advantage of high compression to gain increased performance. They began to design better cars at no greater expense than previous cars. They gave them a more flexible range of speed and power, a quicker pick-up; greater economy; higher top speed. Secondly, the laboratory experiments proved that none of the wasteful expedients such as retarded spark and over-rich carburetor mixture need be employed in the future

to gain the advantages of high compression without danger of the fuel breaking down under the strain.

The average compression ratio used in 1927 was 4.63 to 1. In 1928 this average had been increased to 4.86 to 1. In 1929 it had been increased to 5.06 to 1. In 1930 the average compression ratio was 5.17 to 1. And in 1931 it reached 5.18 to 1. In 1932 it was 5.30 to 1, in 1933 5.53 to 1 and in 1934 5.72 to 1. This is only the average of all models on the American market. Some automobile manufacturers have been slow to take advantage of high compression and so bring this average down, others are already building automobiles with compression ratios over 6 to 1. With the public demanding more and more power, and faster and faster acceleration, there is no doubt that compression ratios will go higher in the next few years.

# RECENT DEVELOPMENTS IN AUTOMOTIVE TRANSPORTATION

*Adapted from an address by W. J. Davidson, Engineer in charge of Research and Experimental Laboratories, General Motors Products of Canada Ltd., to University of Toronto Engineering Society, February 1, 1934.*

Improvement in riding comfort has been the goal of automotive engineers for the past 25 or 30 years. During this time an honest effort to attain this end has been made. Slow but steady improvement has resulted in the development of tires having lowered air pressures and various types of shock absorbers.

In late years, however, engineers have been severely hampered by the principles which underlie the functioning of the conventional suspension system.

It was evident, therefore, to Buick engineers that if a marked improvement in riding comfort was to be accomplished a radical departure from the conventional system was necessary.

In studying the principles which govern riding comfort it was found that the controlling factors are:—

1—Reduction of Front End Frequency.
2—Proper Weight Distribution.
3—Correct Control of Body Movement.
4—Low Pressure Tires .

Buick's experience in dealing with these four factors will now be outlined:

1. Reduction of Front End Frequency:

In the 1933 Buick Models which employed conventional suspension the rate of the front springs was approximately 300 lbs. per inch, and the rate of the rear springs approximately 150 lbs. per inch.

It was felt that a reduction of the front spring rate to about that of the rear springs would result in a decided improvement in riding comfort. This would produce a more nearly perpendicular movement of the body and eliminate the undesirable pitch, the cause of neck snapping and other uncomfortable motions.

The first effort in this direction consisted in lowering the rate of conventional front leaf springs to 250 lbs. per inch. This resulted in a slight improvement—showing that it was a step in the right direction.

The front leaf spring rate was next reduced to approximately 200 lbs. per inch. The riding comfort was materially increased, but several other troubles were encountered:—

First.—Riding clearance was insufficient, the flexible springs

going through easily in the limited amount of space in which they had to work.

Second.—It was necessary to brace the front axle by some auxiliary means in order to maintain proper steering control. The front springs "wound up" due to braking torques and uneven road conditions.

Without this auxiliary bracing the steering was very uncomfortable and did not feel safe. Whenever brakes were applied the caster of the wheels was so changed as to produce dangerous steering.

When the auxiliary bracing was installed the steering control was again restored, but there was a pronounced harshness in the riding which could not be removed and we were still faced with the fact that there was insufficient clearance to handle the amplitude or motion of the flexible springs.

Third.—In reducing the rates of the front springs and at the same time maintaining their proper stress characteristics they had to be made much longer. In fact, as their rate approached that of the rear springs their size did also.

The entire set up was unsatisfactory in that unsprung weight was being added and the cost of manufacture considerably increased.

It was true that riding comfort had been materially increased but not to the extent desired.

All of the work so far pointed to one solution—abandonment of the conventional system of front wheel suspension and the adoption of one which would allow the front spring rate to be reduced as desired and still afford rigid support for the wheels in order to maintain proper steering.

Development work on individual front wheel suspension was, therefore, started. Several types of design were considered including the split axle type, but all were rejected primarily due to the fact that when they were used in conjunction with front springs having low rates, steering control was not passable.

Buick then investigated a type of independent suspension which had been under consideration at Cadillac for some time and which was rapidly proving its worth. This was a variation of the parallelogram construction.

The design consisted of mounting the wheel directly to the frame through two "V" shaped arms, one above the other. The legs of the arms were hinged at the frame, while the tips were fastened together by a vertical steering knuckle support.

A coil front chassis spring was placed between the lower "V" arm and the frame. This construction relieved the spring of all work except that of carrying the load by absorbing all braking torques and driving stresses, leaving the wheel free to move up and down, but preventing movement in any other direction—the wheel, therefore, being held in perfect alignment.

It was first thought that no provision would have to be made for either caster or camber adjustment as these factors are practically constant after assembly. Later development, however, brought

out the necessity for caster adjustment. The system was found somewhat sensitive to proper caster angle and in order to take care of production variation a simple adjustment was provided which need not be touched after proper setting at the factory, except in case of damage to the mechanism by accident.

Camber may be changed by the addition of shims placed at either end of the steering knuckle support. No shims are used in production as the correct camber is obtained by proper machining.

The supporting arms are of different lengths—the upper and shorter one being integral with the shock absorber. The lengths of the arms are so worked out as to make the whole suspension system pivot around the point of contact between the tire and the ground. This means that this point of contact is always the same distance from the center line of the car, regardless of the height of the wheel in relation to the frame.

There is, therefore, no sidewise scrubbing action on the tires as the wheels move up and down following the inequalities of the road, the tread being constant.

Experimentation proved that minimum clearance should be allowed at the hinge points at either end of the steering knuckle support. We found that although these bearings did not seem to wear particularly, even when considerable clearance was present, any looseness would, however, produce uneasiness in steering.

Threaded type bearings were found satisfactory for use at the hinge point on the frame, their characteristic ample clearance causing no detrimental effect.

The use of independent suspension necessitated an entirely new frame work out. The frame now being required to carry loads which had been formerly carried by the front axle. The front end of the frame had to be very rigid and when this had been accomplished it was found that when no frame weave was allowed at the front it naturally worked back along the frame until a place was found where it could weave. This was just back of the line of the dash and caused a bad body shake. The frame was, therefore, reinforced by placing braces between the "X" bars and the frame side members both in front and in back of the intersection of the "X". All frame weave was then eliminated.

A unique method was worked out for fastening the lower support arms to the frame.

A heavy triangular pressed steel reinforcement or "tray" is riveted underneath the center of the front frame cross member along the center line of the car. The lower support arms are hinged to this piece on either side.

Alignment of the wheels in relation to the center line of the car is very important. The use of this tray provides a single piece which can be held to very close limits and when assembled to the frame will insure accurate wheel alignment.

Desiring to know just what would happen to the independent suspension system in case a car was wrecked—a road car was run against a cement wall with sufficient force to wreck the mechanism.

The only thing that happened was that the mounting tray buckled in at the rear. Even with the tray practically ruined and with a considerable amount of camber in the front wheels the car was driven back to the factory where the only repair necessary was the replacement of the damaged tray.

Getting back to the most important feature of independent front suspension from a riding comfort standpoint—the allowable reduction in front spring rate. The front springs are relieved of all duties except that of carrying the load. They can, therefore, be made practically any rate desired. The mechanism can be designed to allow practically any amount of spring ride within reason. Buick's experience indicates, however, that four inches compression and four inches rebound is all that is necessary to obtain the desired result.

The engineer now has complete control of the frequency of car movement and can limit it to the factor necessary for perfect riding comfort.

There has been some discussion as to the desirability of independent suspension for the rear wheels.

As has been pointed out—the primary advantage of this construction for the front wheels is the allowable reduction of front spring rate.

The rear springs already being low in rate would not be benefited by this construction.

Buick due to its torque tube drive has already relieved the rear springs of all braking torques and driving stresses, leaving them no other duty than that of springing the car.

Buick's experience has been that by far the most important advantage of individual wheel suspension is obtained by front end application.

The coil front chassis springs have many advantages:—

First.—They are frictionless, and therefore do not change their rate. They require no lubrication and are not affected by dirt and water.

Second.—Buick tests show they have an extremely long lie. During the entire development of the mechanism only three springs were broken, and these breakages were immediately traceable to surface flaws in the experimental material. Of course when a spring breaks neither steering nor braking controls are materially affected and the car can be driven until a repair is possible.

In adopting the coil spring Buick was up against the problem of making the spring for themselves, as no one was willing to make them to the close specifications which were necessary, The rate had to be accurate, the metal free from surface flaws, the height had to be held within close limits and the bearing surfaces had to be square with the center line of the spring.

In order to prevent surface flaws all stock is purchased centerless ground. After coiling the spring is oil quenched in a semi-automatic machine which holds the spring to the correct height and keeps it square.

The coil spring is so located as to allow a stable shape of spring having a reasonable ratio of spring diameter to wire diameter. The stresses are well within the limits for commercial alloy steel in spite of the soft front suspension.

The physical weight of the coil spring is less than one half that of an equivalent leaf spring.

2. Proper Weight Distribution:

Now that spring rates were under control it was desired to obtain benefit possible from a redistribution of the car's sprung weight.

Many engineers have advocated the balance factor of K /ab ratio approaching 1 as nearly as possible. Experiment has brought out, however, that for Buick cars at least the most desirable ride is obtained when this factor equals .8. The 1934 Buick cars are held as closely as possible to this figure.

The car's weight has been distributed as nearly equal on front and rear wheels as possible for proper handling on turns, cambered roads, etc.

This distribution of weight and mass produced a marked improvement in riding comfort and balance.

Much has been said about the necessity of having the center of gravity toward the rear of the car because of weight transfer towards the front when braking.

While the center of gravity of the Buick cars is slightly to the rear of the geometrical center it is not far enough to compensate for the entire weight transfer during braking from high speed. Under this condition there was a tendency for the front end to duck down. The installation of rubber bumpers inside the coil springs prevent this ducking action. The rubber bumpers being soft enough and of such a shape as to allow no bump as the rubber came into action. The brakes were also designed to allow slightly more braking on the rear wheels than on the front, thereby providing the proper brake balance by compensating for the weight transfer.

3. Correct Control of Body Movement:

The correct control of body movement covers the development work done on shock absorbers and sway stabilizer. It should be remembered, however, that reduction of front end frequency and proper weight distribution were also major factors in obtaining the desired control.

(We will first consider the shock absorber development.)

As the 1933 Buicks were equipped with double acting hydraulic inertia type shock absorbers at both front and rear, this combination was first investigated for use with the 1934 independently sprung car.

It was soon discovered that double acting shock absorbers without inertia control were most suitable for use at the rear.

The inertia shock absorbers, however, were found most suitable for the front. Regular double acting shock absorbers produce a harsh acting front end. This condition may vary with different cars and wheelbase, but for Buick this combination gave the best results over all kinds of driving.

The front shock absorber calibration is very important shift and required considerable effort before the desired result was obtained. A slight change in valving had a very pronounced effect on the riding quality. Once the correct calibration was obtained, however, the result was constant.

As the front spring rate had been reduced one half, any change in front shock absorber calibration was twice as noticeable.

For this reason it is necessary that the proper oil level always be maintained in the shock absorbers and that particular care be taken in the manufacture of the absorbers to see that no dirt of any kind be left inside. Dirt under any of the valves upsets the calibration and has a pronounced detrimental effect on the riding quality.

With the independent suspension there is considerable spring travel and it was found necessary to help dampen this movement by the installation of rubber bumpers inside the coil springs to take care of compression, and rubber bumpers on the frame to take care of rebound. The pick up of these rubber bumpers is such that no shock is experienced, it being impossible to tell when they come into action.

After the shock absorber control has been established it was found that due to flexible springing, body roll or sway from side to side was more pronounced. This led to the installation of a sway stabilizer which controlled side sway and kept the frame level. This also had a beneficial effect on steering in connection with the independent wheel suspension, as the front of the frame did not tip side to side as the wheels moved up and down.

The calibration of the stabilizer bar is important. If the bar is too stiff a harsh action is brought into the rear of the car. If too weak control is lost.

4. Low Pressure Tires:

It was wished to take advantage of the cushioning effect of low pressure tires but when those available on the market were installed they were found to be exceptionally noisy on turns, also steering was snakey. This was thought due to the tread design, so special smooth tires were tried, these eliminated the squeal.

Experimentation with various tread designs brought out the fact that side wall ribbing should be radial and not at an angle. The corners should be well rounded where joining the flat part of the tread.

The number of grooves around the circumference of the tread was important. Three grooves gave the best results except for one make of tire which proved best with four grooves.

It was first thought that after the principles governing tire

noise were discovered that they would be applicable to any make of tire, however, each different make presented its own special problem. This was due to different types of tires carcass construction having different flexibility characteristics.

Angle of fabrics was found to have considerable effect on car wander. Therefore, the side wall construction was redesigned.

When the tires had been correctly worked out they were not only very quiet on turns and straight away driving, but the wear was found very even across the face of the tread with no indication of cupping. Wear tests indicate that the life of these tires is as good or better than the old high pressure tires.

The pressures recommended for these tires is from 21 to 25 lbs. varying with the different models and taken when the tires are cold. When the tires are hot the recommended pressures are three pounds higher.

Skidding tests were made with these new tires on wet asphalt pavement in comparison with the conventional tires and they were found to be considerably superior.

Blow out checks made at 70 M.P.H. both with and without brake application proved the car to be definitely safer than the conventional design.

# BUDGETARY CONTROL AS AN AID TO BUSINESS PROFIT

*Adapted from an address by G. C. McEwen, Vice-President and General Manager of the Imperial Varnish & Color Co., Ltd., of Toronto, delivered on January 23, 1934, to the University of Toronto Engineering Society*

It is a mere truism to state that practically all of us in our private lives must function under some monetary control system or we would soon find ourselves beyond our financial depth. In other words, we can only spend so much or go into debt. The unfortunate thing, however, is that as we earn larger salaries we seem to spend it all and it is only by taking on some responsibilities, such as life insurance or buying our own homes, that we retain an equity. Now and again we hear of some sensible people budgeting their income and when such is the case these fortunate people lay aside some capital for the future.

Budgetary control in business is rapidly coming to the front, although even to-day there is a small minority practising it.

During even what might be considered reasonably good times a large percentage of business houses cannot make a return on their employed capital, but during periods such as this last few years, very few organizations are able to show a profit on their balance sheets. Those who are successful are the ones who know how to forecast the future and can budget their business to show a profit.

The average life of a retail and a manufacturing business is seven years. In the United States and Canada, 21,000 businesses close their doors each year. Rober Babson, the statistician, through his bulletin service some years ago, gave startling statistical figures stating something like the following—that 90 per cent. of the profit made in a single year in the United States was made by less than 10 per cent. of the companies. There is no doubt in my mind that these successful business organizations were all operated by some budget system.

The origin of the word budget is traced back to medieval France —it seems there were strolling players known as "troubadours" and it was their custom to entrust all their funds to one of their company who kept them in a leather bag designated in French as a bougette, and this custodian was known as a budgeter.

In arranging a budget, the board of directors, well in advance of the time their new financial year begins, sit down together and have a full discussion of their business prospects for their new year. Unless some cateclysm, such as war, takes place, it is almost uncanny, after a few years' experience, how close an estimate can be made. For instance, a board of directors might consider they could increase their business in 1934 say 15 per cent. more than 1933. If, after careful discussion this seems a reasonable figure, the sales

manager calls his salesmen in individually and asks them what they think they can do on their territory. You will note that the sales manager does not set the quota for his men, but asks each to sit down and place his proposed quota on paper, which will be retained by the sales manager, so that there will be no mistake when checking is done at the end of the year.

Salesmen under a budget system acquire the propensity of thinking in terms of their own corporation, whereas many salesmen have their customers only in view.

After the sales manager has completed his survey he then tells the chairman of the board that he is ready to place the sales forecast before the directors, and the whole matter is again threshed out and a sales quota is set up. From this estimate the budget is then arranged.

Each single sub-department of the business is carefully gone into as far as expense goes, with the superintendent, office manager, foreman, or in other words, the operative head of said sub-departments. Each one asks for a certain amount of money to operate for the year. This estimate is properly checked by some authority higher up and in some cases may require adjustments. Accordingly, in time the expense end of the business is ready to place in the budget. One very important matter is to see that everyone understands the seriousness of the work so that one and all live up to their estimates.

The budget figures should be completed each month and placed on the desk of the executive who is responsible for its operation. He should be one of the most important men of the board, such as the chairman, president or general manager, and it is essential that it reach him one of the first days of the succeeding month. A careful survey must be made each montth to see that there is no slacking down for one cause or another.

When a company is not operated by a budget, profit, if any, is what is left when all expenses of running the business are deducted. Nothing is known till the end of the financial year and too frequently it is disappointing. On the other hand, under a budget system you set up a reasonable figure for profit and it is one of the charges against your business. It is usually set up as the first desideratum, and is not used in operating. In other words, it is set aside as inviolate and kept intact so that a reasonable return can be made on invested capital.

The speaker then referred to industrial research and illustrated how it was brought into play as a natural part of a budget.

Mr. F. W. Shibley, vice-president of the Bankers Trust Company, New York, is a man who handles sick industrial accounts for his bank. He spoke on budgetary control before the Canadian Club on February 8th, 1926. It would amply repay all my listeners here to-day to obtain a copy of his address.

Mr. Shibley was born near Napanee and originally was a country school teacher. He went to New York a good many years ago and is now engaged in putting organizations on their feet who have

become enmeshed in the hands of the bank. He is successful at his job and, as one might expect, he invariably finds these lame institutions were not operated under a budget system—he immediately sees that they are and not only sets one up, but is the commander-in-chief to see that they live up to it.

Following is a paragraph taken from his address before the Canadian Club:—

"I have seen a corporation, so hopelessly involved in 1921 that its bankers dared not let it go into bankruptcy, pull out under a new management and budgetary control so that it paid all its debts in 1925 and earned better than 10 per cent. on its common stock. I have seen a company, so heavily indebted to the banks that its stockholders threw up their hands and requested the banks to secure new management and attempt to save a portion of their equity, transformed into a most successful operating company in less than two years, by efficient management and budgetary control, with money on hand at the present moment to retire all its banking indebtedness. I have seen a corporation which lost twenty-nine million dollars in three years prior to 1924, transformed into a successful corporation, earning in 1925 about two million dollars, simply by the injection of a new president and budgetary control. I read in the New York *Times* a few days ago a statement from Mr. Edson H. White, president of Armour and Company of Chicago, to the effect that his company had effected a saving of ten million dollars in 1925 through budgetary control."

Sir Joseph Flavelle, one of Canada's most eminent bankers and industrialists, has operated under budgetary control for many years. He always contended that profit is a by-product of a service well conducted.

To operate a successful business he advises that in planning a business a corporate manager or senior executive should place in order of priority:

1st—Consideration for the consumer of his products.
2nd—Consideration for the workmen who make and market the products.
3rd—Consideration of the return upon his invested capital.

Following are a few of the advantages gained under a budget system:

1. A profitable balance sheet assured for the shareholders.
2. Better banking credit.
3. Irradicates the uncertainty and worry of not knowing till the end of the year what your balance sheet will show.
4. Everyone thinking in terms of his own corporation and pulling together in the same direction, fulfilling promises made when estimates were set down.

5. It develops good man-power, plus men standing out in relief while the poorer quality go to the foot, each in his proper place.

Mr. McEwen here pointed out how close budget expenses can be met by giving figures from his own company where in an expenditure on purely controllable expenses amounting to hundreds of thousands of dollars the estimates were not only met but were reduced between two and three per cent.

# LET THE ENGINEER BE HEARD

*Article by C. R. Young, Professor of Civil Engineering*

Whatever may be the cause, the engineer is too much disposed to withhold his opinions on matters of importance to the profession and to the state until he is asked for them. The so-called man of affairs is under no such compunction. He is ready at any moment to deliver oracular pronouncements on anything and everything under the sun, including those upon which he knows nothing. Vigour of assertion being accepted by large sections of the community as tantamount to knowledge, public policies are not infrequently formulated upon advice having no firmer basis than the desire of the giver to hold a place near the centre of the stage.

It thus comes about that public action relating even to technical matters is often determined without the views of the engineer on the broad question having been sought. Summoned before a council, board, or commission, he is confronted with a *fait accompli* and told to design and construct within limits set by those who know little of the economics of planning or of operation, and not much more of the relation of the projected works or facilities to the safety, economic welfare and convenience of the public. It is as reasonable for a group of laymen to determine the fundamental and essential characteristics of an engineering project as for a man with no knowledge of law to undertake the argument of his case in court, or with no knowledge of medicine to treat himself or his friends for serious illness. The engineer can make his value count for most in the formative stages of a project. It is not in the saving of a few tons of steel here and a few cubic yards of concrete there that money is conserved in the carrying out of an engineering enterprise, but rather in the fixing of the broad general lines at the outset.

The resolution and efficiency displayed by the engineer in attacking and solving his technical problems constitutes a demonstration of his fitness for certain tasks beyond the narrow sphere of technology. He has largely removed guess-work from construction and production and can, with an accuracy that astounds laymen, modify environment and make it that much easier for us to carry on. Dealing with constantly changing situations in which the element of danger not infrequently enters, he develops a disciplined mind and controlled emotions. Of necessity be becomes a judge, often between two parties while continuing, with consent, to be in the pay of one of them. The nature of his work forces him to discern clearly between essentials and non-essentials and to reduce conflicting masses of heterogeneous fact to organized data usable in the solution of his problems. The power of summarization, so effective in modern art, becomes his.

These, be it observed, are the attainments of a successful administrator; and since the direction of public affairs is nothing more than ensuring the comfort, convenience and safety of his fellow citizens, the engineer should logically be one of those entrusted with large public responsibilities. One field in which he can obviously contribute much is the co-ordination of production and demand, with the consequent regularizing of employment. Financiers have had a long workout in this sphere, with what result we know to our discomfiture. There is a certain grim justice in the remark of a well known radio orator that when the bankers advise a movement in one direction the public will usually be right if it goes in the opposite one.

## An Ally of Other Workers

Of course it would be invidious to represent that the engineer is alone sufficient for pulling us out of the morass wherein we have rested for too long. The absurdities of technocracy do not need to be enlarged upon. Society must count upon the co-operation of trained workers belonging to all kinds of groups and classes, but when it comes to the matter of factual attack the engineer cannot be bettered. It may be said with assurance that he is better equipped for handling the analytical aspect of public problems than most of those now delegated with that responsibility. Probably one of the reasons that those in authority have so frequently neglected to impress him into the public service is that they feel he has too recently emerged from overalls. Yet, if Flexner be right, and if the essence of a profession "resides in the application of free, resourceful, unhampered intelligence to the comprehension of problems", those engineers who best represent us are units in a learned profession quite as much as is the doctor or the lawyer. There are hosts of cultured technologists on this continent whose attainments confound the local Curzon who disposes of engineers as merely barbarians who can build bridges.

With quiet confidence in his capacity to serve in wider fields than those which he has hitherto explored, it is time for the engineer to shake off his disinclination to take active part in public affairs. The shaping of civic and governmental enterprises should not be left solely to those who instinctively seek public place for the enjoyment of the distinction that goes with it. It is true that those with the toughest hides weather the turmoil of practical politics best, but one of the duties owed by the engineer to his profession, as well as to himself, is to bring to bear for the common good those special qualifications that he possesses.

## What He Might Do

More should be heard of the engineer in contribution to the spoken and the written word. It goes without saying that he should contribute to the technical press and the proceedings of technical societies. Every engineer worth his salt does that. By

no other means can he so well clarify his own mind and organize his knowledge to the point where it can be quickly utilized. Out of the University, he cannot cease to be a student and still be an engineer. The greatest professional men are those who have been the greatest students. Consider, for example, Sir William Osler.

But it is in the neglected borderland between technology and public affairs that he most needs to bestir himself. Being an honest student, he instinctively abhors the burlesque of politics; but nevertheless he should not forget that there are at least some phases of public activity in which the opinion of the engineer may be regarded as of more importance than that of any other citizen, and that it is his duty to make it known. For example, projects in the field of transportation, sanitation, power supply or city planning are ones of which the engineer should have an especially clear understanding, and on which the replenishers of the public purse would welcome his views. Let us hear more from him on these matters at least.

# GEORGE E. COLE

On Saturday, December 16th, 1933, 3T4 lost one of its most popular members when George Cole died in St. Michael's Hospital. George had been taken to the hospital on October 14th, suffering from pains in his back, which it was thought were caused from an attack of pleurisy. The treatment proved unavailing and an operation later revealed that the source of the trouble was a boil, located on his chest, which had discharged inwardly. A very high fever with subsequent periods of delirium resulted. During his illness, many blood

transfusions, given by willing donors, together with George's great determination to live, added new hope. The poison refused to localize and a form of meningitis developed, resulting in partial paralysis of his body. A few days prior to his death he lapsed into unconsciousness from which he never recovered.

George was born November 18th, 1911, and spent his boyhood in Welland, where he received his early education. He entered the University in the fall of 1930 as a student in civil engineering. He was a diligent student and a keen follower of University and School athletics. He was of a friendly disposition and was well liked by those with whom he came in contact.

Besides his father and mother he is survived by a younger sister, Ethel, at home.

The undergraduates and the Faculty deeply mourn the loss of a real friend and a popular student.

ENGINEERS

1934

# YEAR BOOK

OF THE

## UNIVERSITY OF TORONTO ENGINEERING SOCIETY

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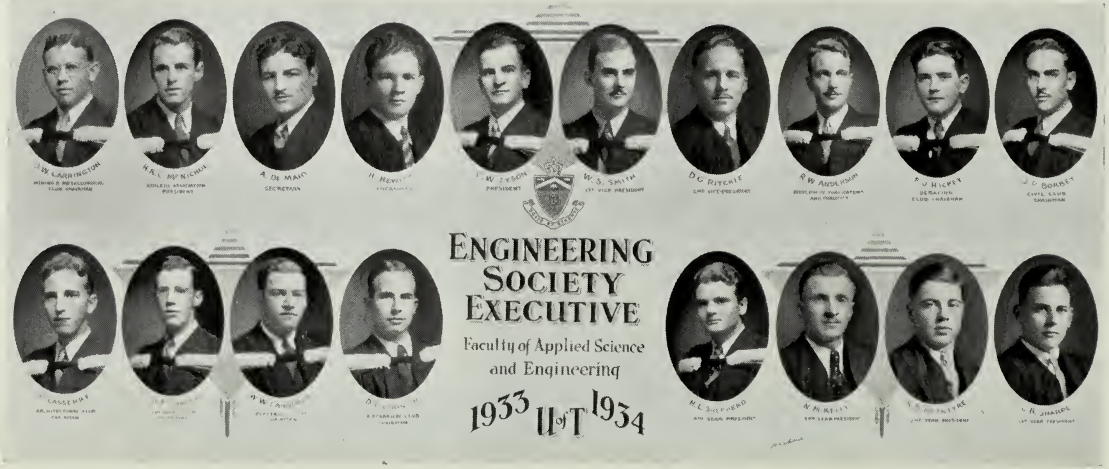
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ENGINEERING SOCIETY
EXECUTIVE
Faculty of Applied Science
and Engineering
1933 U of T 1934
H.L. SHEPHERD
N.M. KELLY
R.A. JAMES

# TWENTY YEARS HENCE!

"Co-ed for President of the Engineering Society", snorted the Prime Minister. "My Gawd! Next they will be having chorus girls on the lab covers and chintz draping around the Drafting Rooms."

"At that", he said, walking threateningly towards the ice-box, "it reminds me of the old days. I never told you about the time that I went to School."

"Go ahead", says we, stifling a yawn, "and we'll try and stay awake."

"Well", said the Prime Minister, expertly flipping off a top and groping for a mug, "it was in the fall of '29 when I came down from the backwoods. I was totally unprepared for the reception that I got. What with tapping, hazing, fights and initiations, I led one helluva life. Finally I found myself in North House and 3 weeks behind in my drafting."

Here the Prime Minister paused for a refill and quaffing off a mighty draught, he continued. "Ah! there were some likely lads I went to School with. There was W. S. Smith, the great scientist, who yesterday made his 17th trip into the stratosphere in his Bromo Seltzer Dirigible."

"Then there was those damn Chemicals who spent all their days in a stinky lab. I always thought they would turn out to no good. Why there was a guy named Don Fraser who never failed to have a raffle on every big event in School. I hear he is the President of the Irish Free Sweepstakes this year. Then there was a lad named Ritchie. I hear he's in the cleaning and dyeing business. You know, combined Turkish Bath and Undertaker Parlours—wotta gag.

The great philanthropist J. Nicodemus Gillies was another cell mate of mine. He said to me one day he'd sell me a dog worth $100—part bull and part terrier. I asked what part was the bull and he answered—that part about the $100."

As the Prime Minister quenched his thirst again we edged towards the door but he was too sly. The door was locked.

"Then there was a certain young Electrical, Farquhar. There was a likely lad. He was the poet of the School. Such things as this came from his trusty pen:

"Try Laxalax, the new cold cure,
And fight the sniffles off.
Two tablets every morning,
And you'll be afraid to cough."

Then there was a prominent young man named McNichol. He rated himself high as a hockey player. He played goal, I believe. He was as fast and as fearless a skater that ever went around a corner on one elbow. His only fault was that he played outfield on a ball team in the summer and sometimes he forgot himself and started to go back for a high shot. Those were some of the things we had to put up with.

A staunch young fellow by the name of Bruce was another young blood of early Engineering Society days. He once told me he knew a man so bow-legged that when he mounted a horse he got both feet in the wrong stirrups. I remember the tap was busy after he cracked that one.

Funny thing happened, one of our great men turned sissy. He turned into a minister. I met this fellow, Rev. Hickey just as he was starting into his morning service. He says to me "Now I'm going to work to beat Hell for an hour." I collapses at that one but manages to grasp my flask for a breather.

Then there was a certain person named Edwards who always kept his gloves on when he called on the finger-print expert's daughter. We always did have trouble with him. Why he thought FLEECE—was small insects and a TREE—one more than two—GUM—to draw nigh or approach. It's no wonder my hair is gray with such men as that around.

Now another young fellow by the name of Dutton caused us much worry and thought. He said he knew a man that was so crooked he could scratch his back with his teeth while standing on his head. Why I heard that he was so lazy that when he was a baby he used to get some other kid to suck his thumb. Wottaman!

"Then there was a guy named Reid and was he dumb. He thought that a slide rule was a baseball term. At present he is trying to run a transit with one hand tied behind his back because he heard someone say that any halfwit could run a transit that way —wotta man."

"I well remember that old philosopher Rule. Much of his School days were given to reflection. Such things as this came from the depths of his mind—'Why use two when one will do'?"

The Prime Minister lighted an enormous cigar and continued to reminisce. "There are times in one's life when one realizes their natural stupidity. The old romantic school called the state of self-hypnotism—'love', realists call it the moronic throwback of infantile orang-outang antecedants. Four out of five suffer from it, each fifth is a damned liar. You may lead a donkey to water but he is a jackass just the same. When I sat down at the piano they laughed, but when I started to play they decided Napoleon was right when he said, 'women and stupidity are synonomous terms'."

At this the Prime Minister reeled in his chair and made just enough noise to wake us up. However he kept on with his reflections. "There was a young whipper snapper called Carrington who always maintained that trying to keep a girl pleased was as futile as lathering the mirror and shaving the image. Now he's up north chasing pegma*tites* and as far as I can see the last of this word seems to be getting the better of him.

At this moment the door burst open and ten kids trouped in. "Tell us a story Grandpa Tyson" they shouted. "Heavens" cried Clarence chewing the end off his cigar. We saw our chance and fled leaving the Prime Minister to his plight.

Our Column

# *Election Results*

FRIDAY, MARCH 2, 1934

## ENGINEERING SOCIETY

| | |
|---|---|
| *President* | D. G. RITCHIE |
| *First Vice-President* | N. M. KELLY |
| *Second Vice-President* | R. B. MCINTYRE |
| *Treasurer* | W. M. LAWRASON |
| *Secretary* | L. B. SHARPE |

## ATHLETIC ASSOCIATION

| | |
|---|---|
| *President* | D. B. BRUCE |
| *Vice-President* | J. A. UPPER |
| *Secretary-Treasurer* | J. J. DUTTON |
| *3T5 Representative* | R. F. GROSS |
| *3T6 Representative* | R. A. BOYLE |
| *3T7 Representative* | C. W. EGGERT |

## CLUB CHAIRMEN

| | |
|---|---|
| *Architectural Club* | J. B. PARKIN |
| *Chemical Club* | F. R. GORRIE |
| *Civil Club* | J. W. POWLESLAND |
| *Debating Club* | A. C. KING |
| *Electrical Club* | V. B. ROSS |
| *Mechanical Club* | L. P. BAKER |
| *Mining and Metallurgical Club* | B. G. EDWARD |

## PERMANENT EXECUTIVE 3T4

| | |
|---|---|
| *President* | H. K. C. MCNICHOL |
| *Vice-Presidents* | H. L. SHEPHERD |
| | W. S. SMITH |
| *Secretary-Treasurer* | J. N. GILLIES |
| *Councillors* | W. W. FARQUHAR |
| | L. D. DOUGAN |
| | C. W. TYSON |
| | J. P. BORBEY |
| | D. F. CORNISH |

## EXECUTIVE 3T5

| | |
|---|---|
| *President* | S. G. FARRAR |
| *Vice-President* | M. WILLER |
| *Secretary-Treasurer* | H. S. MARTEN |

## EXECUTIVE 3T6

| | |
|---|---|
| *President* | G. A. AITKEN |
| *Vice-President* | M. H. HOLLANDS |
| *Secretary-Treasurer* | G. E. SMITH |

## EXECUTIVE 3T7

| | |
|---|---|
| *President* | H. N. POTTER |
| *Vice-President* | L. C. FOSTER |
| *Secretary-Treasurer* | F. C. B. HALL |

BRONZE "S"
T. BELL

# *Elections*

Friday, March 2nd, 1934, saw the passing of the old Engineering Society Executive, and the inauguration of the new.

For a week previous to election day, the main topic of conversation around the old School was elections. Nominations on Monday and Tuesday saw a flood of nomination slips come pouring in and the attendance at the election addresses on Wednesday showed that the enthusiasm was not all limited to the candidates. Heckling and missile hurling proved the candidates were held in deepest awe by their various supporters.

Labs. and lectures were called off by common consent at 12 noon on Friday and a mighty band of Schoolmen made their way to Hart House on the heels of three Highlanders who demonstrated that they too were tough, by having bare knees. Lunch was consumed in silence, except for the usual noise made by some 800 Schoolmen on election day.

At 1 p.m., after a social half-hour spent discussing the gold standard and stuff, the boys came down to vote while the Highlanders strove to drown out the shrieking of sirens and auto horns, the clanging of cowbells and the shouts, cries and pitiful appeals of frenzied candidates and campaign managers.

Any conversation during the actual voting was carried on using the sign language and other very bad language, for it was impossible for the feeble blatting of one human voice to be heard above the general din.

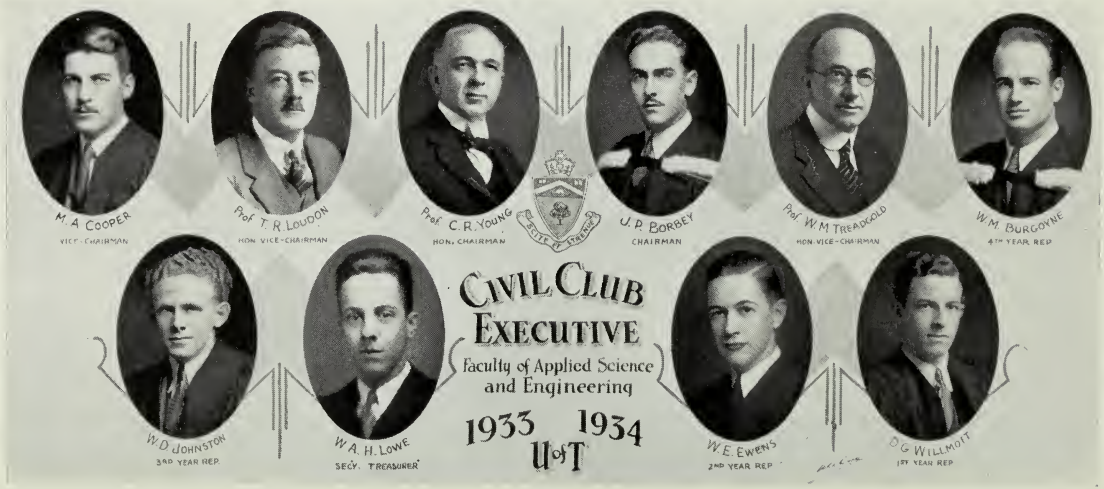
At 3 p.m. polls closed and the ballot counting was begun.

At 7 p.m. the crowd gatherd at Hart House where various athletic feats provided the immediate excitement, with chariot racing in brand new hand-painted, stream-lined, knee-action chariots, the feature of the programme.

The Great Hall at 9 was the next stopping point, and while the returns were being made the gang was fed. After the returns were out, nobody seems to know just where the final stopping place was.

The retiring executive are to be congratulated on a very successful year and the incoming executive deserve the support of every member of the School.

H. L. Shepherd,
*Chief Returning Officer.*


M. A. COOPER
VICE-CHAIRMAN
Prof. T. R. LOUDON
HON. VICE-CHAIRMAN
Prof. C. R. YOUNG
HON. CHAIRMAN
U. P. BORBEY
CHAIRMAN
Prof. W. M. TREADGOLD
HON. VICE-CHAIRMAN
W. M. BURGOYNE
4TH YEAR REP.
W. D. JOHNSTON
3RD YEAR REP.
W. A. H. LOWE
SECY. TREASURER
CIVIL CLUB
EXECUTIVE
Faculty of Applied Science
and Engineering
1933 1934
U of T
W. E. EWENS
2ND YEAR REP.
D. G. WILLMOTT
1ST YEAR REP.

# *Civil Club*

Another academic year is almost over and as we look back we find that our first event of note was the annual Civil Club excursion. This year the trip, under the supervision of Professors Young and Laing, found us at the Canada Cement plant in Port Colborne. Arriving at the plant we were ushered into the recreation room where the superintendent, M. L. Macdonald, explained the steps in the manufacture of cement. Around the room the boys were hard at work jotting down notes due to the fact that Professor Young had invited us to write an essy on the trip. There followed a very interesting tour of inspection, starting with the raw materials at the crushers down to the finished product ready for shipment. With Buffalo so near at hand the gang couldn't be held back and the remainder of the day (and night) was spent in enjoying the sights of this metropolis. On the way home the weary knowledge-seekers crooned themselves to sleep and it was a tired-looking lot that finally returned home.

On November 9th the fall smoker was held in the West Common Room of Hart House. There was a good turnout and soon the room was filled with smoke as the cigars, cigarettes, etc., were passed around. A cigar-smoking contest was staged which created no end of amusement, the winner eventually being a fourth year man. The high light of the evening was the talk given by Dr. T. Kennard Thomson of New York. Dr. Thomson related some of the more interesting events of his life. With this and his droll stories he kept everyone in a hilarious mood. After the address we enjoyed a light lunch in the Great Hall and also a few more of Dr. Thomson's stories told between mouthfuls.

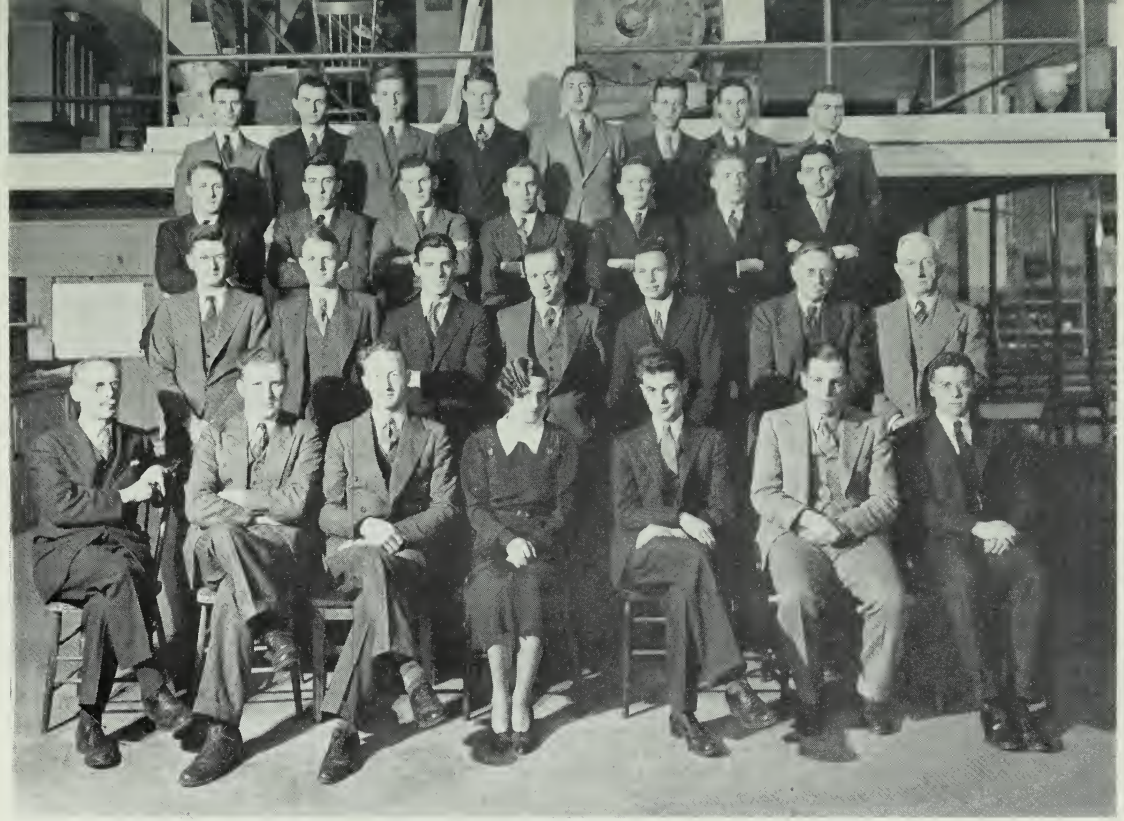
On February 7th a meeting was held at the Engineer's Club in the form of a dinner. The guest speaker, Col. H. J. Lamb of the Dept. of Public Works of Canada, gave a very fine illustrated talk on the "Development of the Great Lakes Waterways System. This meet was well attended and proved to be of great interest to those present.

The executive wish to thank the members of the club for their support throughout the year, and also we hope that the new executive will enjoy every success in the coming one.

J. P. Borbey,
*Chairman.*

FOURTH YEAR CIVILS

*Back Row*: O. E. Johnston, T. J. Carbone, C. MacDonald, J. L. Paquette, H. W. Jeffery, H. G. Waring, J. B. Cooper, K. W. Peacock, C. E. Trim, W. E. Dyke, W. E. Reid, J. N. Gillies.
*Middle Row*: H. J. Hoseason, C. W. Dolbear, G. E. Elford, R. F. Wilson, H. A. Tregaskes, A. J. Nichol, S. J. Furer, G. A. Thompson, R. W. Brotherhood, J. Stubbs, W. O. McBride, N. E. Tregaskes, P. W. Walters, K. B. Kennnedy.
*Front Row*: G. M. Donnelly, A. E. Rule, T. C. Muir, Prof. W. J. Smithers, W. M. Burgoyne, Prof. C. R. Young, J. P. Borbey, Prof. W. M. Treadgold, R. W. Anderson, Prof. T. R. Loudon, C. W. Tyson.



FOURTH YEAR MINERS AND METALLURGISTS

*Back Row*: A. F. Newman, W. R. Moggridge, H. M. Woodrooffe, H. H. Johnston, C. M. Spencer, E. J. Stadtlander, J. H. Salter, Mr. G. Barnes.

*Third Row*: J. C. Eaton, A. C. Gray, P. M. Hedley, G. Dimitrieff, T. T. Tigert, S. A. Hopper, E. O. Hallett.

*Second Row*: H. R. King, R. B. Code, J. Boyd, G. A. Kirkendale, S. A. McCatty, Prof. H. E T. Haultain, Prof. G. A. Guess.

*Front Row*: Prof. F. C. Dyer, R. W. Mancantelli, Mr. S. E. Wolfe, Miss Jordan (Sect.), W. J. Stain, T. J. Wells, J. W. Carrington.

*Absent*: W. A. Carter, W. L. Seebolt.

G. DIMITRIEFF
4TH YEAR REP.
J. C. NICHOLLS
HON. CHAIRMAN
J. W. CARRINGTON
CHAIRMAN
U. H. SALTER
VICE-CHAIRMAN
B. G. EDW
SEC'Y.-TREASURER
A. P. DAWSON
3RD YEAR REP.
J. A. WILSON
2ND YEAR REP.
MINING & METALLURGICAL
CLUB EXECUTIVE
Faculty of Applied Science & Engineering
1933 IIof T 1934
J. J. DUTTON
2ND YEAR REP.
I. L. JENNINGS
1ST YEAR REP.

# *The Mining and Metallurgical Club*

Having built up a reputation for having a club second to none, Miners and Metallurgists saw to it that the season 1933-34 was to be no exception. Wholehearted support by all the members has permitted the Club to maintain its vigorous activities despite "depression rumours" and attendant curtailment of monetary affluence.

The Freshmen were initiated into the Club following the time-honoured custom at a smoker in Hart House early in the fall. Some forty prospective miners and metallurgists, aided and abetted by students of other years, endeavoured to prove that they had other qualifications than a registration card for entering Departments 2 or 8.

Four dinner meetings provided for the more intellectual side of the Club's activities. "Jack" Hammell entertained the students with an interesting account of his prospecting and promoting experiences at the November meeting held at the Engineers' Club. Hart House was the scene of the December meeting. Col. N. F. Parkinson of Ventures Ltd. delivered an interesting address on "Mining Deals"

Our Honorary Chairman, Mr. J. C. Nicholls, was the speaker at the following meeting in January, held at the Engineer's Club. Mr. Nichols spoke of his recent visit to Finland. Mining in Finland is not yet a major industry but it was pointed out that the country's mining future was very favourable.

The Hon. Charles McCrea, Minister of Mines, was the guest at the last meeting. This was one of the best attended meetings in recent years. Mr. McCrea amply fulfilled his reputation of being a capable speaker. During the course of his talk, Mr. McCrea discussed the promising outlook of the gold industry in Ontario. The world gold situation was also reviewed by the speaker.

Social functions consisted of two dances. The At-Home, sponsored by the Toronto Branch of the Association of Women of the Mining Industry, again proved to be an outstanding success. Both tea and pretty girls were generously provided by the women. The second annual Club dance was this year held at Malloney's Art Galleries. The unfortunate absence of patronesses failed to dampen the enthusiasm of the merrymakers and the dance was then and there voted an annual affiar.

Members of the Graduating Class were guests of the Toronto Branch of the C.I.M.M. at a students' meeting held in February at the King Edward Hotel. Papers were read by five of the undergraduates. Particularly is credit due to H. R. F. King and Geo. Dimitrieff for their excellent papers. The papers aroused considerable discussion and the students were congratulated upon their efforts. It is to be hoped that this will become an annual affair.

The excecutive wish to express their gratification for the co-operation received, not only from the students but from the Faculty and our friends downtown. No other Club receives such enthusiastic support from members of the faculty and graduate engineers. We are particularly grateful to our Honorary Chairman, Mr. Nichols, who gave unstintlingly of his time and services. Among the prominent engineers who contributed freely in the discussion following the dinners were Messrs. Balmer Neilly, president of the C.I.M.M.; R. B. Bryce, C. G. Williams, C. E. MacDonald, E. Hibbert and Walter Segsworth.

We extend congratulations to Bruce Edward, incoming chairman, and his executive. We hand over the reins with every expectation that the M. & M. Club will rise to new and higher heights.

Giddap!

JOHN W. CARRINGTON,
*Chairman.*

# *Mechanical Club*

Allowing for poetic license, the Mechanical Club, like February, has just one year more which, it is hoped, has added to the prestige and reputation of the club.

The events of the season varied from industrial plant visits to smokers and an annual dinner.

The Fourth Year Mechanicals, preparing for the years to come, became experienced itinerants—stopping at such places as the "Largest Inches in the World" at Niagara Falls, John Street pumping station on the waterfront, and Mr. McLaughlin's Buggy Works at Oshawa. The Davenport Works of the Canadian General Electric, the Goodyear plant at New Toronto, and the Massey-Harris Co. were plants visited by various other years.

The addresses at the smokers varied from "Arc-welding," by R. L. Smythies, "Hi-Speed Diesel Engines" by A. Craigon, to a talking moving picture of the Abitibi Canyon development presented by R. L. Hern.

The annual dinner at the Engineers' Club was highly successful with Col. McVean as guest speaker.

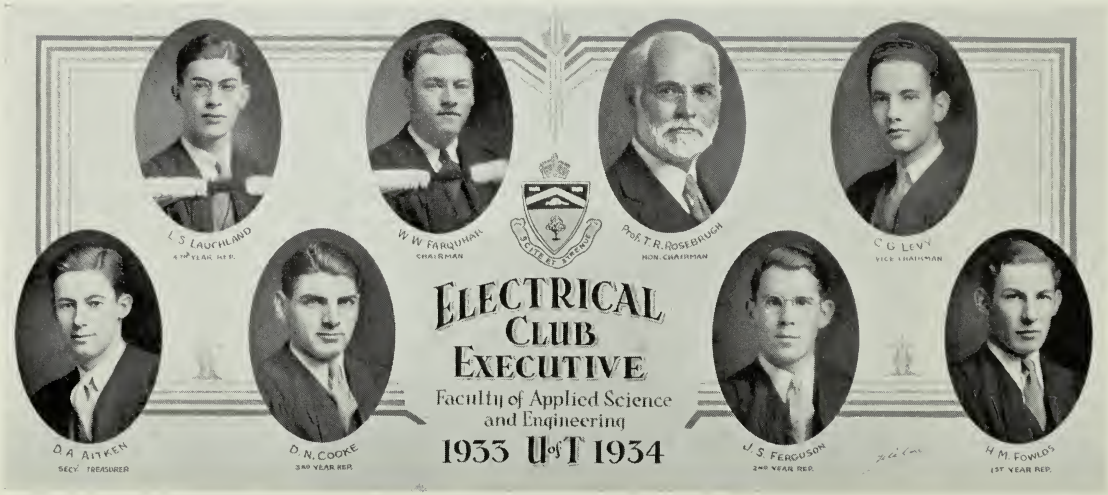
An important development this year was the formation of a Student Branch of the Ontario Section of the American Society of Mechanical Engineers. It is hoped that in the future the Mechanical Club and the Student Branch will co-operate in developing in the undergraduate Mechanicals a feeling of good fellowship and an appreciation of the profession to which they are proceeding.

Donald F. Cornish,
*Chairman.*

MECHANICAL
CLUB
EXECUTIVE
Faculty of Applied Science
and Engineering
1933 U of T 1934
D. F. CORNISH
CHAIRMAN
Prof. W. G. McINTOSH
HON. VICE-CHAIRMAN
Prof. R. W. A.
HON. CHAIRMAN
Prof. R. TAYLOR
HON. VICE-CHAIRMAN
G. A. AITKEN
SEC.-TREASURER
J. F. FAIRLIE
4TH YEAR REP.
J. J. HICKEY
3RD YEAR REP.
W. M. LAWRASON
2ND YEAR REP.
M. I. CARRUTHERS
1ST YEAR REP.

FOURTH YEAR MECHANICALS

*Back Row*: H. E. Fink, J. A. McMillan, H. H. Lightbown, W. A. Heinz, K. R. Shipley, J. C. Knapp, J. A. Harley, S. H. Dowdell, B. P. Henderson, S. N. K. Keyes, R. E. Dutnall, J. L. M. Gilbert.
*Fourth Row*: S. G. Shambrook, W. T. Vrooman, A. S. Wright, R. M. Sinclair, W. J. Henderson, J. A. Hall, H. A. Belyea, W. W. L. Govan, W. Barker, C. E. Hawke, V. S. J. Miliard, T. A. Briggs.
*Third Row*: W. R. Sirman, B. L. Anderson, H. C. Slemin, S. G. Fearman, R. M. Archer, G. E. Ellsworth, W. A. Wilson, J. F. Weston, F. R. Adams, F. H. Dandy, E. G. Gallagher, W. N. Kellett.
*Second Row*: F. R. West, *H.* K. C. McNichol, D. F. Cornish, Prof. R. Taylor, Prof. R. W. Angus, Prof. E. A. Allcutt, Prof. W. G. McIntosh, Mr. R. G. Wiren, J. F. Fairlie,
*Front Row*: J. A. McCuaig, H. G. Kibble, F. J. Hickey, W. A. Higgins, H. R. Clarke, J. G. Jarrell. J. A. Macfarlane.
*Inset*: C. L. Moon.


L. S. LAUCHLAND
4TH YEAR REP.
W. W. FARQUHAR
CHAIRMAN
Prof. T. R. ROSEBRUGH
HON. CHAIRMAN
C. G. LEVY
VICE CHAIRMAN
D. A. AITKEN
SECY. TREASURER
D. N. COOKE
3RD YEAR REP.
J. S. FERGUSON
2ND YEAR REP.
H. M. FOWLDS
1ST YEAR REP.
ELECTRICAL
CLUB
EXECUTIVE
Faculty of Applied Science
and Engineering
1933 U of T 1934

# *The Electrical Club*

With the closing of another year reminiscence is natural and the anticipation of our just reward general. May both be a source of fond recollections and personal satisfaction to you. The graduating class will soon move on, only to be replaced by another; bringing to mind the irony of "time marches on", and the thought of opportunities overlooked.

During the past year our Club enjoyed your support, which was an inspiration to the executive. Also the advice and judgment of the Department Staff was appreciated. It is these circumstances which afford the mental background necessary to accomplishment.

The graduating year made its annual journey to the power plants on the Niagara river and transient points of interest early in the fall.

Prof. H. W. Price favoured us with a guiding and instructive resume in his address, "Inventors and Inventions", in the music room of Hart House. Hardy Sinclair's "School Spirit" was a popular and refreshing added attraction.

Our Annual Dance, held at the Savarin's Windsor room, was a social gem that will take considerable beating. The master of ceremonies apparently had a very touching effect on some of the lads. Gene Fogarty and the Savarin Revue blended into a masterful sensation that cast a never-to-be-forgotten spell over the party.

Mr. A. M. Reid presented a revelation in "Modern Telephony", on our visit to the Bell Telephone Co., which was a panorama of engineering success. On this occasion we realized what complications could arise and that networks do exist.

Mr. F. R. Ewart delivered a highly inspiring speech, "The Engineering Profession", at the Club Banquet up at the Engineers' Club to conclude our programme with a flourish!

We congratulate Bruce Ross on his ascension to the chair and wish him success in his new responsibility. Appoint his supporting executive with as great care as last year and you will help him most.

W. W. Farquhar,
*Chairman.*

FOURTH YEAR ELECTRICALS

*Back Row*: G. F. Hayhurst, L. R. Brown. F. B. Macartney, H. C. Rumble, J. B Gray, A. J. Girdwood, J. W. Lutton, L. S. Lauchland, W. A. Williamson, J. G. W. Crookston, G. A. Clark, R. E. Hendershot, J. A. M. Austin.

*Fourth Row*: H. R. Sumner, W. R. D. Linton, H. Lurie, A. J. Noad, H. L. Shepherd. Prof. H. W. Price, C. S. Phelps, R. D. Cahoon, H. O. Lawrence, F. H. Adamson, C. E. Bannister, J. A. Upper, L. W. Childs.

*Third Row*: H. F. Davidson, H. P. Hamilton, M. S. Jackson, D. A. Palter, H. A. Millen, G. M. Brown, E. H. Tovee, M. H. Redman, W. A. Wood, W. E. C. Wilson, C. A. Norris, H. J. B. Nevitt.

*Second Row*: W. W. Farquhar, R. C. Mitchell. W. L. McAdam. H. W. MacDonald, F. H. Ham, J. E. Lindsay, C. L. Rooney, T. Bickford, L T. Baird, A. R. J. Leary, V. D. MacLachlan, G. R. E. Pitts, M. C. Coutts, S. D. Brownlee, D. T. Niven.

*Front Row*: Assoc. Prof. A. R. Zimmer, Mr. R. J. Brown, Mr. M. Ward, Assis't. Prof. V. G. Smith, Prof. T. R. Roseprugh, Mr. J. E. Reid.

FOURTH YEAR CHEMICALS

*Back Row*: D. F. Roblin, S. J. Neilson, N. Salkovitch, J. R. Joyce, H. Judson, Dr. R. R. McLaughlin, T. Bell, Mr. A. M. Fitzgerald, F. E. P. Griggs, L. D. Dougan, R. L. Hatch.

*Fourth Row*: A. M. Hagerman, F. R. Timson, A. Monsaroff, L. Marks, L. B. Dickout, M. H. Baker, A. M. Vessie.

*Third Row*: G. R. Dance, W. H. Rapson, D. F. Walker, Prof. E. G. R. Ardagh, Dr. M. C. Boswell, R. E. Doull, R. L. Glover.

*Second Row*: J. H. Thompson, Prof. E. A. Smith, Prof. L. J. Rogers, Prof. J. W. Bain, W. S. Halliday, H. C. Barry.

*Front Row*: J. C. Hitchman, J. S. Gray, F. W. Love, N. F. E. Murray, L. E. Oakley, D. F. Fraser, E. Caldwell, R. D. Hill, Miss L. H. M. Greer, J. A. Hall, D. Douglass.

L.D. DOUGAN
4TH YEAR REP.
D.F. FRASER
CHAIRMAN
J.R. MILLS
VICE CHAIRMAN
M.W. HOLLAND
SECY.-TREASURER
F.R. CORRIE
3RD YEAR REP.
K.G. ROBB
2ND YEAR REP.
A.R. STEWART
1ST YEAR REP.
L.B. SHARPE
CURATOR
INDUSTRIAL
CHEMICAL
CLUB
EXECUTIVE
Faculty of Applied Science
and Engineering
1933 II of T 1934

# *The Industrial Chemical Club*

This year marks the 25th anniversry of the Industrial Chemical Club. Originally the Club was organized for the four following reasons:

1. To serve as a medium between the faculty and students.
2. To serve as a medium between the graduates and students.
3. To set and maintain certain standards of professional conduct.
4. To bring the members of the various years into more intimate contact with each other.

In those days, the members of two departments (Dept. 5—Analytical and Applied Chemistry and the present Dept. 6) were eligible for membership in the Club. Even at this the registration of the combined departments was rather small. Chemical Engineering was in its infancy, and the prospective graduates had to depend upon the previous graduates for jobs. Hence reason (2). As the Engineering Society did not function as efficiently 25 years ago as it does to-day, we see the reason for (1). As reason (3) is a subject still under considerable discussion, we will not enlarge upon it.

As Department 6 grew larger, the problem of meeting the members of other years became greater. To-day, this problem has become one of the primary problems of the Club. We believe that this could be facilitated even more by having undergraduates present papers at afternoon seminars. However, the spirit of sociability was very much in evidence at the smokers this year. Hart House was the scene of all the smokers.

"Woody" Woodside, our wandering (not mentally) demi. gave us a description of Nazi Germany at the first smoker. Prof. Rogers, always a loyal supporter of the club, told of his experiences in "Chemistry in the Detection of Crime" at the next smoker. The impromptu debate between Professors Ardagh and Rogers was the high-light of this smoker.

Although "Excursion Day" has disappeared along with the Soph-Frosh banquets and the Second Year draughting room orgies, the Fourth Year Chemicals were able to take a trip in November. The bus took us to Merritton, where we inspected the Alliance Pulp Mills under the direction of Mr. Fair, a former chairman of the club. After lunch at St. Catharines we visited the Hooker Electro-Chemical Co. at Niagara Falls, N.Y. Being so near Buffalo we just had to visit their metropolis, and although the "Red Dog" hounds had been active during the trip, everyone had enough money left to visit the various cultural points of interest in Buffalo.

After Christmas, Bob Willis, chairman of the club two years ago, introduced a new rubber development to us. As usual, at School Nite the Chemical Club provided the physical refreshments while the Mad Chemists of 3T4 provided the mental refreshments (Bell had such lovely curves, and Hill——).

The last smoker featured Dr. Ziedler, consulting chemist, and Mr. Conron of Canada Packers. Both speakers gave us interesting bits of philosophy over which to ponder.

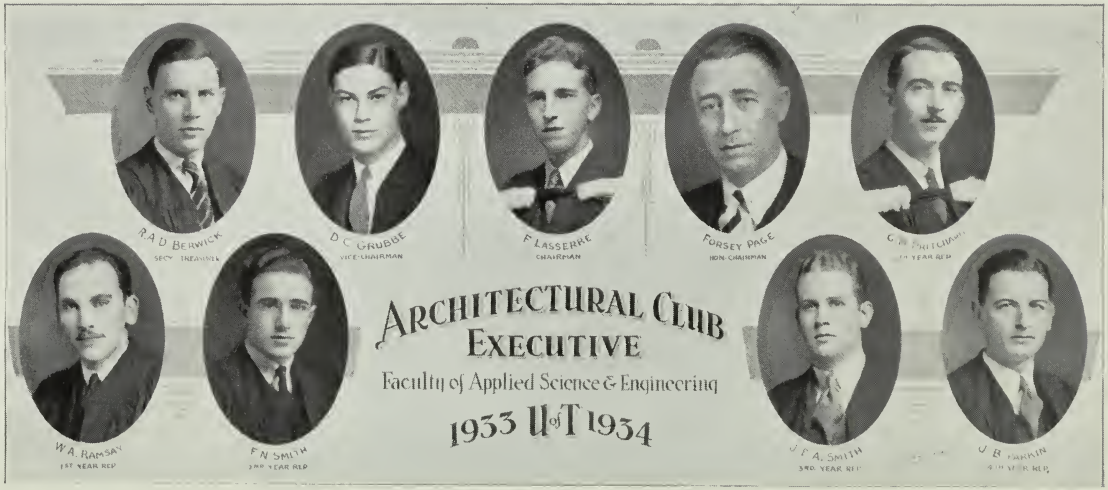
The season ended with the big banquet in March at which the students were able to meet many of the prominent grads. This re-union banquet and the presentation to Professor Bain need not be reviewed—it will always live in the memories of the graduates and students that were present.

In conclusion, we wish you every success in the exams. and ask that you give the same support to Ron Gorrie and his executive that we have enjoyed.

Don Fraser,
*Chairman.*

FIFTH YEAR ARCHITECTS

*Back Row*: F. Lassere, I. F. Brennan, S. Devore, J. B. Langley, G. B. Pritchard.
*Front Row*: Prof. H. H. Madill, Prof. C. H. C. Wright, Miss D. F. Lumley, Mr. M. Waters, J. C. Towers, W. E. Young, Prof. E. R. Arthur, G. H. Piersal.


R A D BERWICK
SEC'Y TREASURER
D C GRUBBE
VICE-CHAIRMAN
F LASSERRE
CHAIRMAN
FURSEY PAGE
HON. CHAIRMAN
W A RAMSAY
1ST YEAR REP
F N SMITH
2ND YEAR REP
ARCHITECTURAL CLUB
EXECUTIVE
Faculty of Applied Science & Engineering
1933 U of T 1934
J F A SMITH
3RD. YEAR REP.

# *The Architectural Club*

The Club enjoyed a rather active season. If the worries and meanderings of the Chairman were an indication of its activities, the Club should have put beehives to shame. Unfortunately, plans and schemes, like dreams, rarely materialize. After the ideas of the Chairman and Executive had been thoroughly sifted, through need of popular support, lack of co-operation and unexpected conditions, a residue remained of a little above average consistency and of a more varied character to that of past years.

The first reunion of the Club took place at Gull Lake, where the Second, Third and Fourth years, under the able tutorship of Professor C. H. C. Wright and Mr. W. E. Carswell, spent a week recording in water colours the charms of the country surrounding the Survey Camp. Perhaps some of the students thought that the only charms to be found were in the village of Minden; however, it was a great picnic, and the results, on display at the end of October, have incited numerous demands from the leading art galleries of the world—maybe not actually, but certainly potentially.

On October the 24th Diana Sweets echoed to the din of our annual banquet. Hilarious entertainment by the nine freshmen and an inspired burst of wit from Bill Armstrong formed the appropriate connecting link between the delectable meal served and an enlightening address by our Honorary Chairman, Mr. Forsey Page.

During the season scholastic drudgery and drafting-room monotony was intercepted by such activities as trips to points and buildings of interest, Club meetings with speakers on allied subjects, conducted tours of the art gallery, drafting room songsters and theatre parties. Also an enthusiastic group was organized at the Art Centre to study and practise, under the guidance of Mr. Charles Goldheimer, various methods of artistic reproduction. All these functions were well sponsored by the students and the appropriate ones by the staff and the Third Year.

The Club celebrated the approach of Christmas at the Embassy. Under any condition it would have been a success, but the presence of Professor and Mrs. Madill made it a super-success. Due to unforeseen complications and lack of enthusiasm, our annual dance, usually the big event of the year, had to be cancelled. Let us hope that next year it will regain its reputation as the culmination of the club activities. Anyhow the Beaux Arts ball is fast becoming a club reunion.

This year was the last active one for the Father of the School of Architecture. As a member of the staff, Professor C. H. C. Wright is no longer present to be "Daddy" to the students, and though his spirit will last long with the Club, his geniality will be sorely missed. In token of its appreciation for his concerned interest in the students and their activities, the Club offered its sincere thanks and wishes by an appropriate presentation. "Long may he live, and well!"

Jack Parkin, the Club's new chairman, is a live wire and he will do his best to provide a program satisfactory to all the various worrying elements in the Club and to certain members of the present Fourth Year. Give him your co-operation, gang; look at the failures of world conferences where the delegates all try pulling their own way. Good luck, Jack. May your crew pull together through the coming season which will be marked by closer connections between the students and the professional body of architects.

F. Lassere,
*Chairman.*

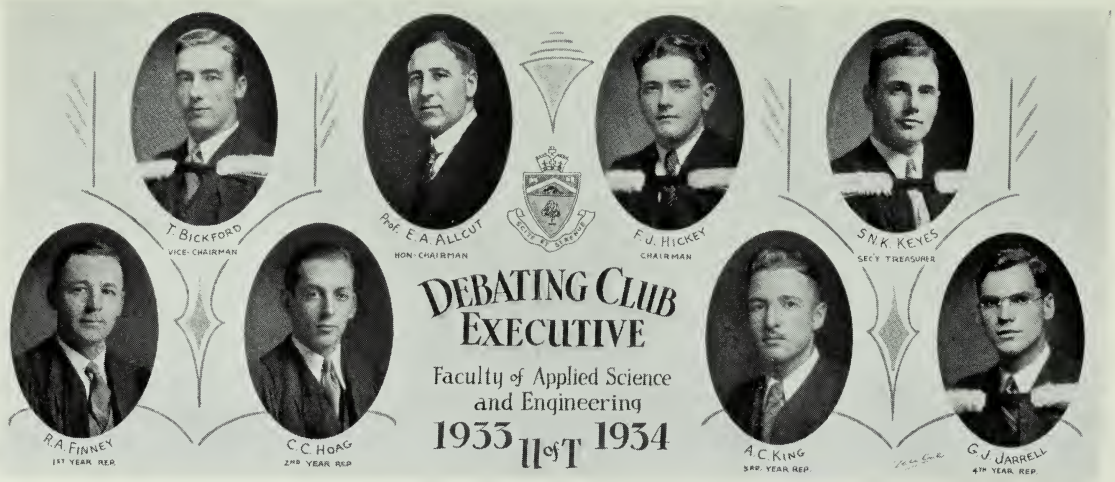
# *The Debating Club*

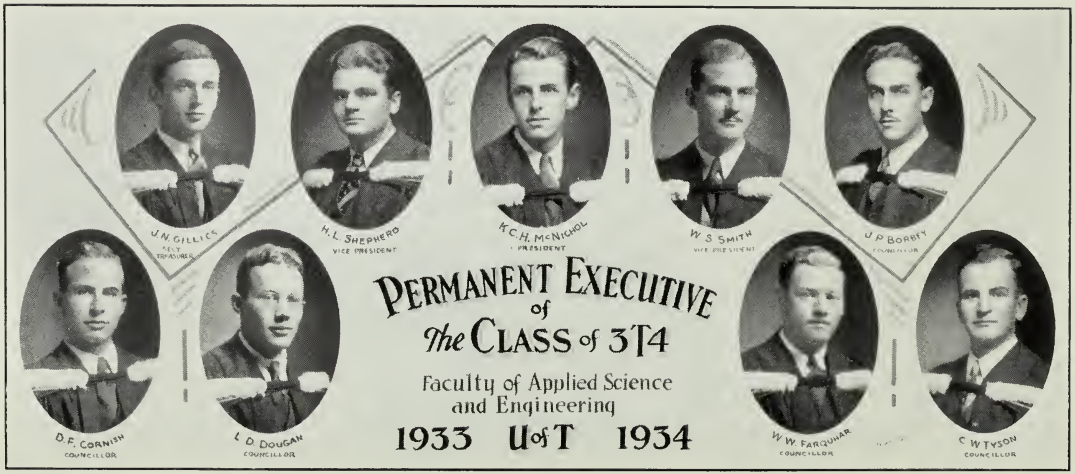
The purpose of the Debating Club is singular in that it affords an opportunity for all concerned to stand on their feet and think as well as talk. It is rather regreatable that the students do not give this organization their wholehearted support, and it is to be hoped that they will give it more consideration in the future than has been the case in the past. Viewed from a purely utilitarian standpoint, which is generally the way an engineer looks at things, this Club offers unlimited possibilities and if given the proper support and co-operation by the students it might even some day be powerful enough to have the distinction, or, as some may say, the indistinction of having Mr. R. B. Bennett address its members.

After getting off to a late start, the Club finally wound up its activities with a bang. The Grand Finale took place at Hart House on March 14 before a near capacity house. The big events of the evening were the oratorical contest, the finals for the Sedgeworth Trophy, and the refreshments. The Sedgeworth Shield, emblematic of the inter-year debating championship, was finally awarded after a tough argument to two members of the second year, C. C. Hoag and F. Stephens. The runners-up were H. C. Kibble and G. J. Jarrell of fourth year, and these two men put up a powerful barrage before succumbing to the attacks of their two more worthy opponents. The oratorical contest provided much interest and many laughs, the prizes being awarded to C. C. Hoag, F. Stephens and J. Harley. After the meeting had terminated, the members adjourned to the Great Hall, where refreshments and smokes were the order.

I would not feel justified if I allowed to pass this opportunity of thanking all concerned for the hearty co-operation they have given me this year. I wish at this time to express my gratitude to our Honorary Chairman, Professor E. A. Allcut, and to all other members of the Staff who so generously offered their time and suggestions for the betterment of our organization. To the members of the executive I say "Merci" and "Adieu", but I hope not goodbye, and to "Red" King, the new chairman, I wish the best of luck and success in the coming year.

F. J. Hickey,
*Club Chairman.*


T. BICKFORD
VICE-CHAIRMAN
Prof. E.A. ALLCUT
HON-CHAIRMAN
F.J. HICKEY
CHAIRMAN
S.N.K. KEYES
SEC'Y TREASURER
DEBATING CLUB
EXECUTIVE
Faculty of Applied Science
and Engineering
1933 U of T 1934
R.A. FINNEY
1ST YEAR REP.
C.C. HOAG
2ND YEAR REP.
A.C. KING
3RD. YEAR REP.
G.J. JARRELL
4TH YEAR REP.


J. N. GILLIES
SEC'Y-TREASURER
H. L. SHEPHERD
VICE PRESIDENT
K. C. H. McNICHOL
PRESIDENT
W. S. SMITH
VICE PRESIDENT
J. P. BOBBY
COUNCILLOR
D. F. CORNISH
COUNCILLOR
L. D. DOUGAN
COUNCILLOR
W. W. FARQUHAR
COUNCILLOR
C. W. TYSON
COUNCILLOR
PERMANENT EXECUTIVE
of
The CLASS of 3T4
Faculty of Applied Science
and Engineering
1933 U of T 1934

# *Message of The Permanent Executive, 3T4*

Four years ago two hundred very green men entered this institution for the purpose of learning something regarding the engineering profession. Many have grasped the light—others are still looking for it. At last, however, the day of graduation is near. Four years of trying to get to lectures on time, getting lab. reports in on time and passing exams., have had their effect on us, but we are now on our last lap. In a very short time our college days will be a thing of the past.

3T4 has been a great and successful year, the last of the old guard. Always has 3T4 tried to uphold the traditions of Old School and with the best of success. Our initiation was the last real initiation School ever had. Also some fellows are still wondering why they had to pay $1.00 for a certain affair at Burwash.

Now that your activities as undergraduates are drawing to a close, you are all welcomed to the status of an alumnus. Contacts formed at School are easily enough retained so long as one remains on the campus, but after graduation—then what? You will want to know what your friends are doing and they want to keep in contact with you. What are we going to do about it?

You have elected a Permanent Executive, whose main duty will be to answer all questions and to keep 3T4 one big happy family.

You are going to hear from us soon and we would like a hearty response. It is up to you whether the Class of 3T4 is going to be an active organization or just a name. Only through your letters and your active part in any Class programme can we keep 3T4 united. So how about it! If you are working let's know how and where—if you're not, let's know anyway. All news will be welcomed by us and you will be doing your part to keep 3T4 together. Your letters can be addressed to the two addresses below or to any other member of the Executive. Do not forget that if you change your address let us know at once so that we will not lose track of you.

The Executive wishes you all success in your future endeavour and till you hear from us again, the Best of Luck!

*President,*
H. K. C. McNICHOL,
64 Indian Trail,
TORONTO, Ontario,
Phone Ll. 4681.

*Secretary-Treasurer,*
J. N. GILLIES,
53 Geoffrey Street,
TORONTO, Ontario,
Phone Ll. 3731.

# Fourth Year Executive

Faculty of Applied Science and Engineering

1933 U of T 1934

# 3T4

In a very short time the members of the class of 3T4 will become graduates and settle down to the task of getting jobs, wives, and families, maybe; and as the years roll along they will look back with no regrets upon the past four years.

In the first year we were educated to the ways of all Schoolmen by the famous class of 3T3, and under the capable leadership of Jim MacFarlane we settled down to try and become the equally, if not more famous, class of 3T4. The first annual Soph-Frosh party, the Burwash massacre, the excellent Junior School rugby team and various other achievements of merit, along with a small amount of work, were the highlights of our initial year.

Having become Sophomores after the results of the spring assizes at the end of our frosh year, we administered the last of the famous S.P.S. initiations and its success was proven by the fact that initiations have been barred ever since. Under the leadership of Bob Anderson we kept up our reputation by having a couple of exceedingly successful year parties. Thus we passed into the Junior Class in which our athletic achievements were even more numerous than those of the first year.

In the Junior Year, Mike Kellet took the helm and was the instigator of the Junior-Sophomore dance, which was, with the exception of School Nite, the outstanding informal dance of the season.

The past year, our last in the Red Schoolhouse, has been one continuous round of activity. The clubs have been exceedingly active; the Engineering Society has thrived under the fatherly hand of Ner Tyson; the Senior School Rugby team won the Mulock cup and the Graduation Ball ended the social season with a memorable bang.

May the memory of the past four years gladden the hearts of 3T4 men throughout all the years to come, and may the permanent executive, spurred on by Harp. McNichol, keep the Burwash Light Brigade united until the last dog is hung

H. L. Shepherd,
*President.*

# 3T5

Much praise to 3T5 for the support given the past three executives! I say this because 3T5 boasts of being the first Third Year to hold two year parties during the school year successfully.

Our social activities began early last fall with the Junior Dance, held at the Parkdale Canoe Club, which was a great success. Then came the January Hop in the Blue Room of the Sunnyside Pavilion which was quite "doggie".

The ample representation on all teams has won for the individuals concerned the appreciation of the year as a whole. Not only represented on School's interfaculty Rugby team, winners of the Mulock Cup, but also on the Intercollegiate Track team, of which Ronnie Westheuser is perhaps the most outstanding.

While preparing for our examinations we might look back at the successful two years just past, in which Doug Bruce and Don Ritchie brought our Year to the front not only financially but socially. As Freshmen we saw Doug salting away a $100.00 bond for our fourth year (I guess he's going to get his year), while Don at the head of the Sophomores saved 3T5 financially with respect to our initiation activities and brought us out of second year with a surplus of $80.00. This work deserves much credit and shows wonderful spirit in 3T5.

A curtain will be drawn over our Third Year activities on the night of our last exam. ??? Yes, it is our regular fling which will be held this year in the Blue Room of the Sunnyside Pavilion.

So, gentlemen, with the best of luck and plenty of confidence in "Gray" Farrar, Murray Willer and Howard Marten we pass along the book of 3T5 plus a surplus of $10.00. A $100.00 bond plus a surplus of $10.00 bank balance plus a little support will give us one grand graduation year. What do you say?

Nels Kelly,
*President 3T5.*

# 3T6

In the fall of '33, the somewhat thinned-out ranks of 3T6 returned to enter upon its second spasm of S.P.S. life. After the preliminary hand-shaking and joke-swapping, the lads began to concentrate on the annual Freshman problem. This year the problem was particularly tough, but it was finally solved, using a combination of Ohm's law and a vector diagram. On October 20th, the refining plant did its good work and left a feeling of good-fellowship and good "Schoolmanship" in its wake.

The Year was then entertained on a large scale by the Freshmen at the Annual Soph-Frosh party held in the banquet hall of the Royal York. The First Year executive is to be congratulated on the success of that function.

The next dark cloud on the horizon was the Christmas exams. Following these, beards were shaved in preparation for much merrymaking at our first Year Party, which was held at the Parkdale Canoe Club. Success is the only word to describe that party, at which 220 engineers, men of brain and brawn, displayed their agility in treading the light fantastic.

Then followed a period of learning (?) during which time daylight began to flicker through some of the heavy fog. Then we were awakened by the sound of approaching elections, and thus an excuse arose for having another dance. On February 28th, the Parkdale Canoe Club was again torn up by the roots by the joy-making men of 3T6.

The athletic activity of 3T6 has been remarkable. There was scarcely a team, whether Interfaculty or Intercollegiate, that did not have a 3T6 man on its line-up. A mere glance through the sports section will show how completely we were represented.

In closing, gentlemen, allow me to say that it has been a pleasure for me to act as your president in one of the most glorious years. The entire executive thank you warmly for your support. We feel that we have done our best. However, the new executive, headed by George Aitken, will undoubtedly be able to introduce many improvements. The best that we can wish them is that they receive as good support in the coming year as the retiring executive has had in the past one. Best of luck.

R. B. McIntyre,
*President 3T6.*

# *3T7*

As we look back over our first year at S.P.S. we find it hard to believe that so many events have occurred in such a short time. We well remember our first few days at the Little Red School House when we were speedily introduced to "dont's for freshmen", green ties, and, last but not least, the time-honoured custom of tapping. For the next few weeks the campus was alive with groups of nervous-appearing youths banded together for the mutual preservation of green ties. But we were not to wear them for ever. Finally, the twentieth of October came and with it the initiation. When the evening finally came to a close we wended our weary way homeward with possibly a few far-fetched plans for next year's reception.

Then came our first university dance. The Soph-Frosh reception held in the Royal York banquet hall was attended by some three hundred and fifty Schoolmen and their "one-and-only's". Good music, an entertaining floor show and an abundance of novelties all combined to make this party a long-to-be-remembered event. But all good things must come to an end and with the first streaks of dawn we finally arrived at our respective lodgings.

For the next six weeks we turned our thoughts to the pursuit of elusive knowledge. We handed in numerous lab. reports and spent hours arranging to borrow lecture notes. Christmas drew near and on the evening of December the fifteenth we held a dance at the Parkdale Canoe Club, unofficially closing the term in a blaze of glory.

Throughout the year the Freshmen of S.P.S. have had a worthy representation in the realm of athletics, both Interfaculty and Intercollegiate. Without singling out anyone for special mention we can say of all who represented S.P.S., and they were many in number, that they played the game well and were a credit to S.P.S. in general and to 3T7 in particular.

With the school year drawing rapidly to a close we just had time to squeeze in a final get together on Tuesday, March the thirteenth. In spite of adverse weather conditions over one hundred couple spent an enjoyable evening at the Parkdale Canoe Club. And now with elections just passed and with enough blotters to absorb all the water in Hart House pool, we come into the last stretch. And so in closing we want to thank the members of 3T7 for the interest shown in our class activities and to ask them to heartily support our new executive and make our Sophomore year bigger and better than ever.

L. B. Sharpe,
*President.*

# *School Dinner*

The 44th consecutive annual School Dinner is but a pleasant memory which still lingers in the minds of those Schoolmen who were loyal to tradition. The 1st Annual Consolation Dinner for the lady members of the Engineering Society, an innovation this year, is recollected by seven certain young ladies as the reason for a very happy evening too. Without a doubt these two dinners will go down in the famous annals of School history as the most successful ever presented.

Following several weeks of toil and trouble with academic work taking a back seat, the very energetic committee witnessed the culmination of their efforts on Tuesday evening, December 5th, 1933. Approximately six hundred students besieged Hart House on that occasion and the seating capacity of the Great Hall was certainly taxed to its limit. The overflow which could not be accommodated in the Faculty Dining Room were comfortably seated in the lower corridor.

The decorative system erected on the tables and suspended from the walls was indubitably the most superb display that ever dazzled the eyes of Schoolmen. The programme is still the cause of congratulatory comment of those fortunate enough to procure a copy. Everything in conjunction with the dinner was new, novel, and different and certainly carried on the traditional glamour of former years. It will be very difficult in future to surpass the excellence of this function but Schoolmen are able to accomplish anything they tackle.

Sir William Mulock started the dinner with his unique presentation of the Mulock Cup to the victorious Senior School Rugby Team. The stirring eloquence of his address proved a fitting commencement for the evening. Next came a real sumptuous turkey dinner with all the essential trimmings. The dessert this year was particularly attractive and palatable in its engineering aspect. An orchestra ground out delightful music during the course of the evening and served to drown the sounds of the gurgling of soup and gnawing of bones. Digestion was assisted after the Toast to the King by a short and lively sing-song led by Ross Workman in his inimitable manner.

The speeches of the evening were few in number but of exceeding good quality. Clarence Tyson, President of the Society, proved an excellent chairman and controlled everything admirably. Colonel C. S. L. Hertberg, a graduate of our institution who is practicing in Toronto, proposed the toast to the University in a very witty manner. Mr. J. J. Gibson, prominent in local financial circles and a member of the Board of Governors of this University, replied to this toast. He received the hearty approval of everyone by his mention of his regard for engineers and the reason why. Dean

F. R. WEST
TICKET SALE
D. I. CORNISH
ACCOMMODATION
C. W. TYSON
PRESIDENT
W. S. SMITH
CHAIRMAN
J. P. BORBEY
VICE CHAIRMAN
R. W. ANDERSON
FINANCE
J. A. HARLEY
ENTERTAINMENT
J. A. MACFARLANE
RECEPTION
J. B. LANGLEY
ADVERTISING
SCHOOL DINNER COMMITTEE
Faculty of Applied Science and Engineering
1933 U of T 1934
W. G. ARMSTRONG
DECORATIONS
H. K. C. MCNICHOL
MARSHALLING

Mitchell had the attention of all as he explained his definition of the theory of probability. Then he ably introduced in his genial way the great event of the evening—our guest speaker.

Dr. O. O. Lefebvre, Chief Engineer of the Quebec Streams Commission and this year the President of the Engineering Institute of Canada, neglected his duties as a public servant in Montreal and graced the head table for the evening. He extolled the merits of the Institute and spoke of their association with student organizations. As an engineer of great experience he delivered some very excellent advice on the difficulties arising in engineering practice. It was indeed a treat and pleasant change to have a speaker representing the French element of Canada and his message was gladly received.

A rousing "Toike Oike" and "Toronto" made a grand finale for the evening. The corridors were still echoing with these ear splitting yells as the members filed out and another dinner was registered in the pages of the ages.

W. Stanley Smith,
*Chairman.*

# *School At-Home*

The greatest advertising campaign ever staged on the campus ushered in the 1934 edition of the School At-Home. "The" party was the main topic of conversation in the University quarter of the city for at least two weeks previous to the dance. The daily papers avidly swallowed stories of date bureaus, blimps, sandwich board men, until we had sufficient free advertising to warrant paying for some.

However, the party proved a greater success than was expected. Dreamy music, shadowy lights, beautiful ladies and the usual School spirit combined to enhance the traditional glamour of this function and produce the foremost dance ever presented by the Engineering Society. The scintillation of this School At-Home will linger amongst the pleasant memories of everyone for years to come.

The popular Wright Brothers' Orchestra excelled themselves with their tantalizing million dollar melodies as they made their last Campus appearance. Wes and Lisa Adams exceeded all expectations with their sinuous gyrations and Cuban interpretations. The crowd showed their whole hearted approval in the manner by which they pressed around the dancers.

As midnight chimed Walter Winter caressed the console of the mighty organ and enticed the throng into the Concert Hall. The sonorous tunes formed a pleasing background during the sit down supper. This year the menu met with considerable disapproval but every plate was cleaned, nevertheless. For your enlightenment, however, there is more chicken in an egg than in "chicken a-la-king".

U. S. GRAY
GUESTS
MISS D. F. LUMLEY
PUBLICITY
W. S. SMITH
CHAIRMAN
C. W. TYSON
PRESIDENT
W. A. HIGGINS
FINANCE
J. H. SALTER
ENTERTAINMENT
H. J. WILKINSON
ACCOMMODATION
SCHOOL AT-HOME
COMMITTEE
Faculty of Applied Science & Engineering
1933 U of T 1934

The blue, gold and white colours of S.P.S. predominated in all the decorations. The mammoth crest of this faculty made a bright spot on the north wall, and if you noticed was just an enlargement of the cover design on your dandy programme.

The Patronesses included Mrs. H. J. Cody, Mrs. C. H. Mitchell, Mrs. C. R. Young, Mrs. H. E. T. Haultain, Mrs. R. W. Angus, Mrs. C. H. C. Wright, Mrs. J. W. Bain, Mrs. H. W. Price, Mrs. G. A. Guess, Mrs. W. J. T. Wright. Representatives from Queen's, McMaster, O.A.C. and all other faculties lent added distinction to the affair with their colours.

All previous records were broken by an official attendance of 320 couples, which exceeds last year by 100. Thus the dark days of dubious depression are vanishing. Of course, notwithstanding the constant surveillance of Gord. Jarrell and Jenkins, another fifty couples managed to crash in. The committee is very pleased that the result of their efforts met with such great approval. We wish to thank those who so patiently waited in the foyer until 2.30 when they were allowed to sample a real party. We consider it a tribute to the acknowledged supremacy of the School At-Home on this campus that so many outsiders should try so hard to avail themselves of the opportunity of saying they were present.

W. Stanley Smith,
*Chairman.*

# *School Nite*

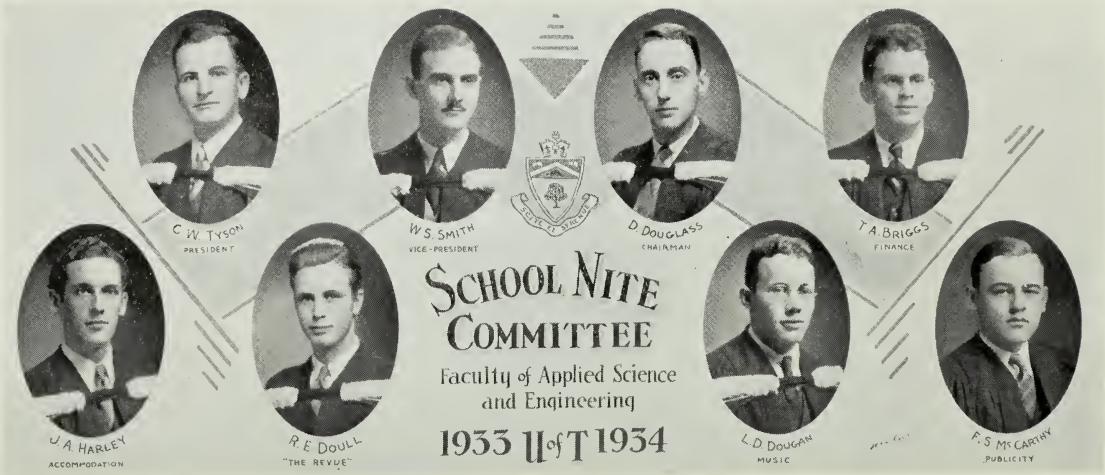
When a brief two weeks had elapsed after the dreaded Christmas exams, Schoolmen were ripe and champing for an opportunity to trip the light fantastic and view the efforts of their peers in the realm of the drama. This all signifies that on Friday, January 19th, School Nite occurred, or should we say took place. Fun and games were the order of the evening.

We were honoured in having as patronesses: Mrs. E. A. Allcutt, Mrs. R. R. McLaughlin, and Mrs. C. A. Smith. This year, following the plan inaugurated last year, it was decided to hold skits in the form of "The Revue" in the large gymnasium. The first performance began at 8.30 and continued on into the second without intermission.

Dancing to John Crawford and his orchestras took place in the big gym, East Common Room, Reading Room, and the Music Room, continuing until 1 a.m.

In the Water Polo game, Senior School managed to take their Juniors just as Grant took Richmond, with an exhibition of fancy diving between periods.

Messrs. The Mad Chemists of 3T4 delighted (?) the audience with their burlesque of the Hart House kitchen while the Civils


C. W. TYSON
PRESIDENT
W. S. SMITH
VICE-PRESIDENT
D. DOUGLASS
CHAIRMAN
T. A. BRIGGS
FINANCE
J. A. HARLEY
ACCOMMODATION
R. E. DOULL
"THE REVUE"
L. D. DOUGAN
MUSIC
F. S. McCARTHY
PUBLICITY
SCHOOL NITE
COMMITTEE
Faculty of Applied Science
and Engineering
1933 U of T 1934

added a touch of reverence to the occasion with their "Pearly Gates" scene.

Messrs. Bell and Hill out-terpsichored Terpsichore with their charming effort at dancing while Bill Armstrong and his horse "Pansy" had them rolling in the aisles.

May I take this opportunity of thanking Mr. Bickersteth, Mr. Gilley and his staff for the invaluable assistance rendered the committee.

I should like also to thank the members of the committee for their excellent co-operation in making the evening a success, and also the School men who supported it so well.

D. Douglass,
*Chairman.*

# *Graduation Ball*

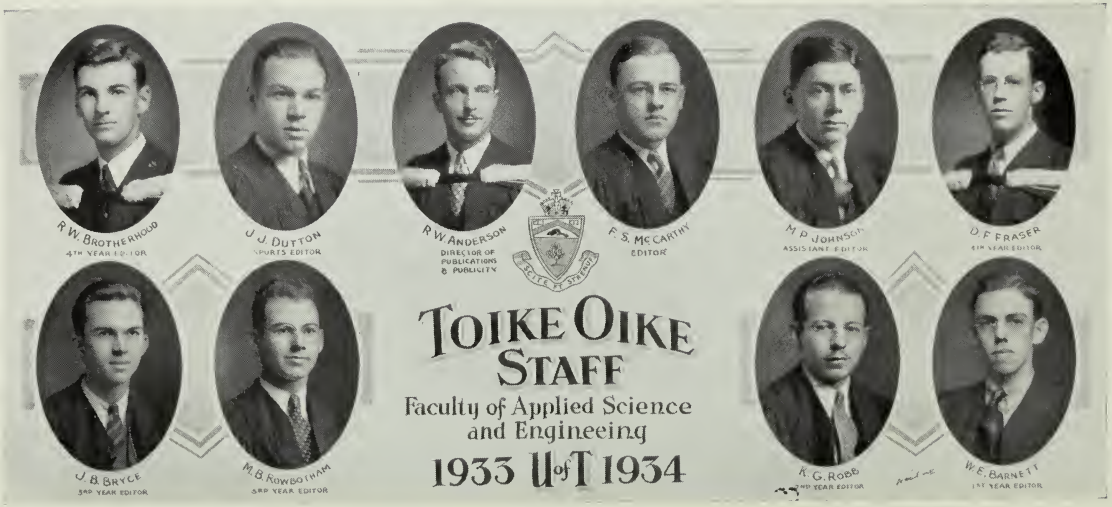
On the evening of Thursday, March 15th the Class of 3T4 held their last party as undergraduates in the Roof Garden of the Royal York Hotel. While Ed. Houston and his band supplied the music, the crowd supplied the pep; vim and gin (synthetic). No one thought then of April 12th and the trials and tribulations yet to come but rather of the past four hilarious years and the last glorious binge—and what a binge.

The far seeing committee had managed to obtain a hall, band and food (all at the same time) and so everyone came to the party, small and tall, girls and all. Even the Chemicals came in their charming khaki cutaway coats and even in overalls—sweet, ingenuous boys; how they froliced and danced and capered and pranced, and what a simply lovely time they had, and how pretty they looked with their rosy cheeks and sparkling eyes and bulging hip pockets.

Then there were soft lights and music, and myriads of beautiful girls and the funny man who always said boom! when the band stopped playing and the funny man who said boom! whether the band played or not and that peculiar revolving elevator full of very many revolving elevator men and the white shirts and striped pants—quite a party indeed!

Promptly at about 3.00 the orchestra played "God Save the King" and the party was officially over and some of the weak sisters left about 4.00 or 5.00.

The School At Home was a success, but to the class of 3T4 the Graduation Ball was "our party" and never before was there such a night, and never will there be again.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1933 U of T 1934
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1ST YEAR EDITOR

# *The Toike Oike*

As everybody knows the Toike Oike is published "every now and then" by the Engineering Society and is devoted to the interests of Schoolmen.

During the past year there were eight issues which contained, among other things, advice to freshmen, welcome to returning graduates, information about social events, advertising for election candidates, sport news and other articles of interest to Engineers.

Issues of note were the reunion edition, which contained a message from President Cody, articles by graduates and, for the first time in years, outside advertising, and also the election edition which was the largest Toike Oike ever published.

Outstanding on the staff were Jim Dutton, who wrote the Sportoike, and Ben Bryce, who supplied the year's stock of humour.

We would also like to take this opportunity of extending our thanks to contributors for the good grace with which they submitted to the imposition of writing articles, and for the promptness with which they turned in their copy, and express the hope that they will be as obliging to the new editor and his staff.

In closing, let us remind you that there will be room for workers on publications staffs next year so that, if you are interested, now is the time to place your application.

F. S. McCarthy,
*Editor.*

# *Gull Lake*

The Fourteenth Camp is over! Once again the tranquil shores of Gull Lake have suddenly awakened to the raucous laughter, the boisterous shouting, and the playful pranks of Schoolmen; and as suddenly have they returned for another year to their habitual calm.

The fifteenth of August, I say, this rude awakening came to those peaceful hillsides—nor were the surrounding hamlets totally ignorant of what was taking place. Highways were cluttered with disreputable looking vehicles conveying incredible numbers of engineers toward their goal. Local trains chugged northward to an accompaniment of School ditties, and even the near-by lakes were thronged with engineers' craft. Such, then, was the arrival of 3T5; forty loyal Schoolmen invading their University Summer Home.

Formalities were soon over with—beds selected and suitably labelled; canoes procured by fair means or foul, and the camp was on. There followed six weeks, perfect in every detail. The weather from the first was excellent. Seared backs and pealing noses bore this out only too well. The days, it is true, were filled with work.

# GULL LAKE

MINERS · 1933 · CIVILS

Determined Civils ran highways through hills and bogs to the most absurd places. Others, not so ambitious, turned their eyes to Heaven, searching for stars that never appeared. Ardent miners tore up the countryside tracing contacts, finally sinking a shaft in some cottager's backyard.

If the days were full, the nights were even more so. Long moonlit nights to be spent drifting on the glassy lake (ref. Patterson and Farrar); dance nights in Carnarvan and Minden to dispel any gloomy moments; nights by a camp-fire, lulled by the music of Raquettey Creek; (ref. Miller and Van Loon); nights offering all a man could ask.

Hardly a week of this had passed when the engineers felt it their duty to play host to the country-side. Word was spread near and far that a dance was to be held in the "Bunkhouse" on August 23rd and on that eventful eve some sixty couple moved rhythmically to the enticing melodies of "The 3T5 Gondoliers". Who could ever forget music rendered by Bert Patterson (the demon pianist), Hermie Hertz and his clarinet, Pete (Rubinoff) Dawson, Trumpeter Jim Smith and Ron Westhauser and his guitar? Not one, I say!

A few days later the Miners went to town. One Saturday the citizens of Minden awoke from their habitual lethargy to find a "Street Fair" in progress. Having been duly subdued by the oratorical grandiloquence of Paul Hedley, they were provided with a brand of entertainment that will live down in local history.

Then came the Labour Day week-end! To prepare the boys for the regatta, a dance was held on the preceding Saturday. For this event the dormitory was transformed. Beds changes magically into soft chesterfields; bright lights were dimmed to the correct softness; a forest of evergreen decorated the walls and roof and floors were polished to a glistening sheen. The Gondoliers once again provided sweet music and Mrs. Minto served an excellent lunch at half-time. Skits had been arranged for the intermission and were well received until Hart Van Loon brought the house down with a roar by losing his towel in the middle of the "Hula-hula".

The regatta followed on Labour Day with all honours on that occasion going to Ron Westhauser, who was acclaimed camp champion. Every man in camp entered at least one event and the day was voted a huge success by all.

A corn roast was held the next night, a strictly stag affair, and was attended by almost all the camp members. What happened to the absentees is a story in itself, but we still have visions of Gord Sutherland fishing in the lake for his bed.

Those then, gentlemen, are days to be remembered well; days we will look back on with a great deal of pleasure. To 3T6 we hand the reins (leaving an improved ball diamond and a newly decorated bunkhouse), confident in the knowledge that the Fourteenth Camp was the best ever.

"Ball of Fire".

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T. BELL
4TH YEAR REP.
R. D. WALDEN
3RD YEAR REP.
ATHLETIC
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1933 U of T 1934
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2ND YEAR REP.
V. A. UPPER
1ST YEAR REP.

# *The School Athletic Association*

In a resume of Interfaculty Athletics for the past year School has made a very impressive showing. Very keen interest was taken right from the opening of the fall term and continued incessantly throughout the year.

The Outdoor Track Team once again came through to win the Interfaculty meet, as did the Indoor Track Team, later.

The hard-fighting Senior School Rugby Team after a strenuous campaign tied Victoria, last year's champions, in the finals in overtime. This necessitated another game which School won by a decisive margin. This is the first time since 1928 that the Mulock Cup has been held by S.P.S. It is to be hoped that School will keep up the good work.

The Gym Team, holders of the Harold A. Wilson Trophy for the past three years, were nosed out by Meds, but deserve honourable mention.

The B. W. and F. Team won the Junior Assault, but lost out to O.A.C. by a small margin in the Senior Assault.

In the Interfaculty swimming meet School placed second. A good many of this team also played waterpolo. The Senior School team made a strong bid for the Eckhardt Trophy, but were defeated in the finals.

After winning the toughest group in the league Junior School Baseball Team was defeated in the semi-finals.

The Senior Hockey Team also were defeated in the second round of the semi-finals, after winning a hard group in fine style.

The Senior School Basketball Team on paper look like the team to beat for the championship, having several old intercollegiate players in their line-up. They are still going strong.

As usual School was well represented in Intercollegiate sports, including rugby, soccer, track, hockey, swimming, waterpolo and B. W. and F., the first and last mentioned particularly.

A debt of thanks is due to J. A. "Scotty" MacMillan, who turned out faithfully all season and coached the rugby team to the championship.

The Athletic Association, with the assistance of the Engineering Society, introduced a new crest and new honour letter this year which will be registered and used exclusively in the future. Another inauguration was that each year the members of championship Interfaculty School teams be presented with a miniature sterling silver "S" which will be a standard size and design purchased on a contract from The Lackie Manufacturing Co. when required. The allotting of these to be at the discretion of the Athletic Association Executive entirely—*e.g.*, a man shall have played in 50% of the games.

The Athletic Association Executive would like to express their appreciation to all the managers for the excellent way in which they carried out their duties and aided in making this year such a successful one.

H. K. C. McNichol,
*President.*

S.P.S. "T" HOLDERS
1933-34

*Back Row*: E. O. Hallett (B. W. & F.), R. H. Miller (Rugby), J. C. Eaton (B. W. & F.).
*Second Row*: J. B. Gray (B. W. & F.), C. E. Bannister (B. W. & F.), W. M. Burgoyne (Rugby), C. L. Annis (Rowing), R. G. Alison (Rugby).
*Front Row*: J. P. Hooper (Swimming), T. Bell (Rugby), R. G. Westheuser (Track), R. E. N. Davey (Soccer), J. A. C. Bowen (Soccer), G. Dimitrieff (B. W. & F.).
*Absent*: K. W. Peacock (*Rugby-Captain* 1933-34), N. F. E. Murray (Hockey), H. R. Collins (Basketball), Miss D. Lumley (Ladies' Hockey).

# *The Bronze "S"*

The bronze "S" this year has certainly again found a worthy holder. In previous years it has been held by men of great athletic ability and general good fellowship, but it has probably not been held by such a versatile and genial athlete as its present one, Tom Bell.

"Tubby" Bell plays numerous sports and plays, each one with the same degree of skill, steadiness and sportsmanship. In the fall of 1933 he was regular snapback for the Intermediate Intercollegiate rugby team which won their group so handily, and in 1934 he stepped up to the Senior Intercollegiate championship team where he played regular snapback and on the centre secondary defence. For his merits on this team he was awarded his bronze "T".

"Tubby" is also a strong swimmer and has represented the University for two years on the swimming team. He finds the 200 and 400 yard races quite to his liking.

In water polo he has led School teams to numerous victories and helped to keep them in the race for honours. Almost all the water polo teams on which he has played have won their group only to be nosed out in the finals.

Lacrose is another sport to which Mr. Bell adapts himself quite handily. Since box lacrosse started in the big gym he has been playing for School and each year has proved him to be an outstanding performer. This year he also played for the University team in their games against the Rochester Indians.

Nevertheless, in spite of his many successes and popularity, he will perhaps be remembered better, the robust, genial "Tubby" Bell as he was known in the labs. and lectures.

S.P.S. "S" HOLDERS
1933-34

*Back Row*: G. A. Aitken, R. D. Cahoon, H. F. Bengry, R. E. Bates, G. R. Davidson, W. A. Campbell, L. P. Baker.
*Sixth Row*: H. E. Finch, H. T. Turley, F. A. Fleming, H. G. Waring, D. B. Thomas, H. A. Hornfelt, J. P. Hooper, S. K. Brigham.
*Fifth Row*: A. C. King, B. H. Carveth, H. A. Millen, R. G. Westheuser, J. A. C. Bowen.
*Fourth Row*: I. C. Knapp. T. J. Wells, H. H. Johnston, W. D. Johnston, W. W. Farquhar, D. Douglass, A. E. Hall. L. R. Brown.
*Third Row*: D. F. Fraser, R. L. Miller, R. Hewitt, D. B. Bruce, J. W. Powlesland, R. E. Davey, B. I. Cooperman.
*Second Row*: C. W. Tyson, W. O. McBride, R. F. Gross, Miss D. Lumley, H. K. C. McNichol, J. K. Ferguson, J. A. McArthur.
*Front Row*: W. W. Freeland, R. J. Birss, C. E. Bannister, A. E. Rule, P. W. Walters, H. B. Ashenhurst, C. E. Burnett.

# *School in Intercollegiate Sport*

Glancing back over the activities of Varsity teams for the past term one cannot help noticing the prominent part taken in Intercollegiate Athletics by the undergrads from School.

When we returned to the U. of T. last autumn, squads of ambitious rugby players were being drilled into form by Canada's best coaches. As the teams started on their long grind to the championships, we found the names of many Schoolmen on the line-ups in our Stadium Magazines. The Big Blue Team claimed Ken Peacock as their captain and a middle player, Bill Burgoyne at flying wing, Tubby Bell at snap and Ronnie Alison as an end player. Well may we remember some of the battles as we cheered the team on in their last minute victories against McGill and Queens. It is little doubt indeed that all the Varsity squads were victorious when we see the number of our men who wore the sweaters of the Blue teams. Boomer, Hornfelt, Welch and Perry—"our import" played on the Varsity II's, while the Juniors hung up such enviable scores aided by Holt, Thomas, Powell, Woods and O'Connell. It might also be remembered that "Dick" Miller and "Art" Upper helped Argonauts win the Dominion Rugby Championship. With men of this calibre Varsity will be hard to hold next year because the old proverb still holds "As School goes—so goes Varsity."

Perhaps you will also remember how amused you were at the games of Rugger which sometimes preceded the big games. R. C. Crawford, one of our number, was our sole representative in this game which is rapidly gaining popularity around the campus.

The Varsity Soccer team, which won the championship, had Rex Davy in goal, Jack Bowen at full-back and Dave Johnston on the forward line. It is four years since School was represented on the Soccer Team.

The Track Team went down to Queen's determined to break McGill's monopoly on the McGill Trophy but the opposition was too strong. Ably representing us on this team were, Ashenhurst and Hogg, "our two Flying Freshmen," Joe Gandier, Johnny McArthur, Fred Smith from the Sophomore year with Ronnie Westheuser and John Hickey from the Junior year. Fleming and Walkey were included on the Intermediate Track Team, while Hogg was our lone rep. on the Harrier Team.

The Golf Team claimed "Whitey" Lathrop, a freshman, while Tubby Bell and Bert Hamilton were on the Varsity Lacrosse Team in its battles with the Rochester Indians. The Blue Swimming were strengthened by five S.P.S. men—Hooper, Eggert, Jennings, Wood and McCuaig. We were rather disappointed that our waterpolo enthusiasts were not regarded as intercollegiate calibre.

During the winter months our Boxers, Wrestlers and Fencers (?) had been enjoyed the capable coaching offered them in the Hart House Gym and their efforts were crowned when six of them were

MONSAROFF
SNAP.
Mc BRIDE
MIDDLE
BRIGHAM
INSIDE
GROSS
INSIDE
WARING
QUARTER
BAKER
MIDDLE
FARQUHAR
HALF
POWLESLAND
MIDDLE
DOUGHT
HALF
WALTERS
OUTSIDE
WEBBER
HALF
Mc NICHOL
HALF
MULOCK
CUP
BRIDGLAND
HALF
DAWSON
F. WING
GLOVER
OUTSIDE
SENIOR SCHOOL
RUGBY TEAM
MULOCK CUP
CHAMPIONS
1933-34
MOFFATT
LINE
COACH
MACLACHLAN
OUTSIDE
MUIR - HALF
ASST. MAN.
WALDEN
F. WING
MACMILLAN
COACH
WEST
MANAGER
BROWN
SNAP
WILLSON
MIDDLE
BAIRD
OUTSIDE
ELLSWORTH
QUARTER
WELCH
OUTSIDE
KING
F. WING
FINCH
HALF
HAYHURST
INSIDE
MOOR
OUTSIDE

picked to represent Varsity at the Intercollegiate scrap. Dimitrieff, Eaton and Hallett, "three Mighty Miners" showed power and class enough as wrestlers and boxers to gain individual honours and the Tom Gibson Cup for the Blue Team. Bannister was defeated much to everyone's surprise, Freddie Smith lost an unpopular decision and Sid. McCatty lost a game bout on points. Holden, Millson and Hunnissett were included on the Intermediate B.W. & F. team.

Possibly due to the heavy schedule and the early exams, Schoolmen do not take as much interest in Varsity Hockey and Basketball teams. Jeffrey and Williamson were on the Senior O.H.A. team while Hamer, O'Leary, Upper, Walkey and Wilmott played for the Juniors. Miss Dama Lumley was goalie for the Champion Varsity Ladies' Hockey Team. M. R. Mitchell, a freshman, was our only representative on the Basketball squads.

School's Gym Team, as a body, helped the U. of T. team bring the Caron Cup back to Toronto. Beard, Barber and Lewis were our three gymnasts.

The Varsity Rifle Team, the second best team in Toronto, also had the entire S.P.S. team as members. Thompson, Clark, Broad, Pickett, and Tutton are our Sharp shooters.

Many Schoolmen wear off their surplus energy on the Varsity Rowing Teams under the capable coaching of our own popular Prof. T. R. Loudon who has trained the Varsity "Eight" to bring back the Intercollegiate honours for the past six years.

Part of the training offered at this great University is the chance to learn to "play the game" and the opportunity will never be better and the time more ripe than the present. Every undergraduate should avail himself of the opportunity and coaching offered by taking an active interest in at least one line of athletics.

## *Senior Rugby*

The team started the year under the capable managing of Croff Muir who was injured during the third game of the season, and as a result the job of Water Boy fell into my unworthy hands.

The series passed with many a struggle. The boys had to fight every inch of the way. During the second game with Meds, our position was quite uncertain. In the last half-minute of this game the score was 4-3 for Meds, then a sawbone dropped the ball and a Schoolman fell on it. Final score 4-8.

The Dents were taken care of in the group playoff and Trinity was taken for a ride in the semi-final. Good old Vic was now blocking our way to the title. We should divert from the usual here and mention that just 24 hours before the game with Vic someone muttered to the Water Boy that Chuck Bridgland couldn't

SCHOOL B. W. & F. TEAM

Junior Assault Winners 1933-34

S. A. McCatty, J. C. Eaton, J. C. Millson, E. H. Wolfe, S. G. Fearman, M. G. Halden, C. E. Bannister, Ges Dimitrieff (Manager), E. O. Hallett, H. L. Minaker.

play, and sure enough the rumour was well grounded in spite of the fact that everyone thought differently. We can take off our hats to those sportsmen on the Victoria team for allowing Chuck to finish the season.

The first final with Vic ended 2-2 with four overtime periods on a heavy field. Even after this struggle, in which School showed superior playing at the end of the game, the Varsity (which is usually slow in recognizing School talent) was betting 3 to 1 on Vic.

The following week all School players had mud cleats. The parade through the Vic line began at 2.15, continued even during half time by a few of School's Old Maestros, and ended to the tune of Toike-Oike and a score of 11-0.

The Water Boy would like to burst out with a lot of emotion right here about co-operation and all that sort of thing, but we'll skip it.

Yes, the series was a lot of hard work, time sacrificed, and labs. missed for the players, and then there's Scotty MacMillan, the man behind the scenes, who spent so much time away from his office to coach a bunch of hard boiled engineers.

Let's give a great big hand to 30 of the hardest fighting Schoolmen and their Coach for winning the Mulock Cup for the 14th time in its forty year existence.

FRANK R. WEST.
*Manager.*

# *School B. W. & F. Club*

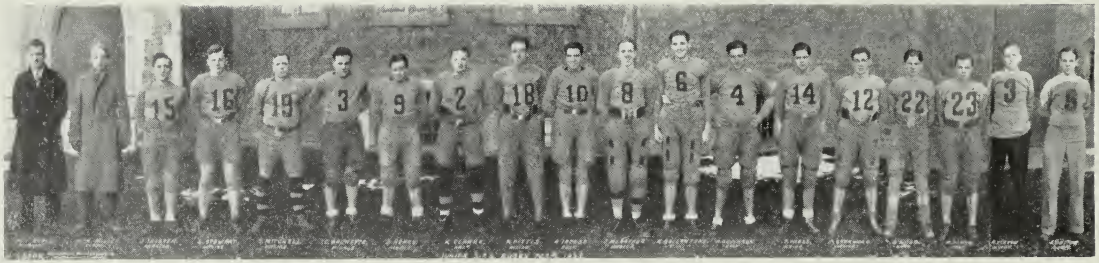
As soon as lectures had commenced in the little Red Schoolhouse, boxers, wrestlers and fencers began thronging to Hart House in an effort to get rid of surplus energy which they had acquired during the summer months. The first competition held was the School assault, which proved to be one of the best in years. The wrestlers far outnumbered the boxers and so keen was the competition that Coach "What-a-man" Martin's smile reached across the room as he chuckled with glee. The winners who were awarded medals were:

Wrestling: Beard, Tigert, Dickout, Tyson, McKillop, Trimble.

Boxing: Houle, Gooch.

In the junior Interfaculty Assault which is limited to inexperienced men, School took most of the bouts to win handily. McCatty and Fearman won their bouts in the 135 lb. and 175 lb. classes by knockouts. Halden won the 135 lb. wrestling and Cavanagh turned in a win for fencing.

After Christmas the boys settled down to serious training, the boxers under Dr. Les. Black and Harry Henning and the wrestlers under Cliff Chilcott, Olympic star. When the Senior Interfaculty



JUNIOR SCHOOL RUGBY TEAM

1933-34

Ron. Boyle (Manager), Dick Miller (Coach), Troster, Stewart, Mitchell, Brunette, Henry, Clarke, Pittis, Jacobs, McArthur, Ballantyne, Davidson, Press, Sherwood, Wood, Young, Mason, Dutton.

*Absent*: Thompson, O'Leary, Schmitt, Hall.

Assault came along School had a team which looked hard to beat but luck dodged us. Gray, twice Intercollegiate champion, was out with an injured knee, McCatty was injured in winning his bout and could not continue and Millson was forced to give way because of a cut over his eye. The result was that O.A.C. took the assault by three wins. School winners were:

Boxing: Smith, Hallett.
Wrestling: Bannister, Eaton.

At the Intercollegiate Assault School supplied six of Varsity's team even though Gray was out due to his injury and Fearman could not compete because of his father's illness. Smith, former Intercollegiate champion, dropped an unpopular decision and McCatty, fighting in spite of injuries, was nosed out after a game fight. This was recompensed by "Handsome" Hallett, the knock-out kid, who floored his man like a ton of bricks. In the 145 lb. wrestling, Jim Eaton beat everything in sight to win easily. The 4th year Miners hung up an enviable record when in Hallett, Eaton and Dimitrieff they supplied three intercollegiate champions out of a class of thirteen. Certainly as School goes so goes Varsity's B. W. & F. team.

This year practically the whole team graduates. It is up to the incoming freshmen to make a new team and any man with average physique who works can make the Intercollegiate team.

Before deciding not to learn boxing, wrestling or fencing consider these facts:

1. Hart House Gymnasium is the best equipped in Canada.

2. Time between 5.00 and 6.00 p.m. which is otherwise wasted could be used to good advantage.

3. The coaches—Dr. Black and Cliff Chilcott have not only proven themselves to be the best boxers and wrestlers in Canada but they are by far the best coaches in Canada.

4. Four months of hard training, going in the ring and getting beaten all over the map will do you more good than six books of calculus or a hundred lectures of economics and finance.

G. Dimitrieff,
*Manager.*

# *Junior School Rugby*

Once again the younger Schoolmen upheld the traditions of the fighting engineers. Although the squad did not make the playoffs they did, however, under the capable coaching of "Whitey" Miller, make it tough for all opponents.

The initial game of the season against Jr. Meds, was a heart-breaker for School. After leading 4-1 till the final quarter, they saw their lead wiped out when the Meds pulled the "hidden man"

SCHOOL TRACK TEAM

INDOOR AND OUTDOOR CHAMPIONS 1933-34

*Back Row*: ASHENHURST, KRAILO (Assistant Manager), COHEN, BRUCE.
*Front Row*: MCARTHUR, BURNETT, DOLBEAR (Manager), HICKEY, WESTHEUSER, HOGG.
*Absent*: PROF. E. A. ALLCUT (Hon. President), MITCHELL, FERGUSON, FLEMING, DENNIS.

trick, who snared a nice forward pass and galloped 50 yards for a touchdown.

Revenge was sweet, however, in the return game, but two wins from Forestry and two losses to Trinity completed the season. Worthy of honourable mention is the practice with Sr. School in which the casualties in five minutes' scrimmage were: 1 broken nose, 2 head cuts and 1 black eye. Nasty men! Eh, what?

On the whole, the boys were worthy of being the younger brothers of the Mulock Cupholders. Congratulations, Sr. School!

Ron. Boyle,
*Manager.*

# *Outdoor Track Team*

S.P.S. got away to a flying start in interfaculty athletics by winning the interfaculty outdoor track meet. The Schoolmen piled up a total of 39 points to easily win the meet from University College, who registered 23 points to take second place, while Meds. gathered 19 points for third place. The supremacy of the Schoolmen is well illustrated by the margin in points.

Due to the loss of trackmen such as Adams, Fitzpatrick and Hymmen, due to graduation, Schoolmen were certainly not favoured to win this year's meet. However, two speedy freshmen, Ashenhurst and Walkey, School's pick for the sprints and 440, came through to win School's first points against some very speedy opposition. John Hickey, School's intercollegiate hurdler, put up a great race in both hurdle events only to be nosed out by Passmore of O.C.E., while Hogg, another School freshman, showed great form by winning second place in the mile. Westheuser, holder of the intercollegiate discus record, easily won that event by breaking his old record with a toss of 123 feet, $7\frac{3}{4}$ inches. Gandier and McArthur, two sophomores, added 13 more points to School's list. Gandier won the high jump with McArthur a close second, and McArthur then nonchantly won the broad jump to add another School victory.

Many of School's track and field stars are still in Junior School and with several years Engineering still ahead of them, they will give a good account of themselves in defending the Nowell cup in future years.

C. W. Dolbear,
*Manager.*

JUNIOR SCHOOL BASKETBALL

1933-34

*Back Row*: J. A. McArthur, C. W. Eggert, F. M. O'Flynn, A. J. Herchoran.
*Front Row*: H. J. Wilkinson (Manager), A C. Rogers, S. Murray, R. H. Miller. B. Cherofsky, C. A. Miller.

# *Indoor Track Team*

After a bad showing last year, the School indoor track team came back strong this year to win the championship and the Toronto Cricket Club Cup.

The victory was marked by the outstanding performances of Austin and Hogg. The former captured the standing broad jump, the standing high jump, and placed third in the running high jump for a total of eleven points, while the latter was the first Schoolman in years to place first in the mile and two mile runs.

Ferguson added another win for School when he carried off the honours in the pole vault. Ashenhurst and Burnett scored points in the sprints and the quarter mile events respectively.

The long standing dominance of the School relay teams remained unbroken as the half mile relay team of Powell, Ashenhurst, Burnett, Mitchell, Fleming and Dennis, and the mile relay team of Ashenhurst, Fleming, Burnett and Krailo broke the tape in the fastest time in their respective events.

The track team will be little changed during the next year, we hope, and, with the aid of new material, has all the odds in its favour to repeat this year's brilliant performance.

F. Krailo.
*Manager.*

# *Junior Basketball*

There was a large turnout of good players this year and it proved a difficult task to choose the squad.

In the group besides ourselves were Pharmacy and Senior Meds. We had very little trouble in defeating the Pharmacy aggregation, but the Meds. proved to be a hard nut to crack. The medical students were all crack shooters, experienced ball handlers and turned out to be a little too strong for our clever but more inexperienced team. It was not, however, without a stiff fight that the Meds. were able to finally put us out of the running and enter the play-offs.

There was always wholehearted co-operation; every man turned out enthusiastically to the practices and did his utmost in the games.

Although we did not go very far in the series this year there is undoubtedly some very good material in the team and far better results may be expected next year.

H. J. Wilkinson
*Manager.*

SENIOR SCHOOL BASKETBALL TEAM

Interfaculty Champions 1933-34

*Front Row*: Hickey (Coach), Walden, Caldwell, Douglass, Hall, Mitchell (Manager).
*Back Row*: Cooperman, Wilkinson, Reid, Black, Hagerman, Cahoon.

# *Senior School Basketball*

It is unfortunate that at the time of writing, the playoffs for the interfaculty championship are still in progress, which makes us hesitate to start with the caption "Sifton Cup Winners". But if ever a team was of championship calibre it is this year's outfit and it will be a smooth team that beats them.

The squad had,—three men with Sr. Intercollegiate experience, two with Intermediate and the rest had four years of interfaculty basketball and last of all, Del. Hickey of St. Mike's Big Six Team to direct the play.

So it was little wonder that Sr. Vic. were snowed under in two games 23-9 and 29-9. The Dentists' Sr. outfit provided stronger opposition, almost too strong as School were forced to come from behind in the first game to win 17-15; the second game was again close, the score being 26-20 for the engineers.

And then the playoffs. A ten-day lay-off caught the boys cold, in more ways than one, and the desperate battle with Sr. Meds resulted in a heart breaking one-basket defeat, Sr. Meds coming up beautifully from seeming defeat to finally hoop the winning basket for a score of 26-24.

Determined to have another crack at Meds, the Forestry team was run into the floor, giving School a 37-21 victory.

A victory over the medical students in the next encounter will probably produce a tie in the playoff group, but the boys are confident that they can take the doctors every time from now on. So it should occasion no surprise to see them in the finals and then cup winners.

These potential champs are: Ted Douglass, Jack Reid, Hugh Wilkinson, Ralph Waldon, Ed. Caldwell, Ken Black, Berniche Cooperman, Aub. Hagerman, Roy Cahon and Hal. Collins.

Robert C. Mitchell,
*Manager.*

# *Junior School Water Polo*

As in former years, the annual call to arms for the maintenance of School prestige in the Hart House tank brought forth many eager and hopeful aspirants. It was found that only three of last year's team, Ron Boyle, Maurice Hollands and Ken Clarke, were eligible and the work of building a team around them was begun.

The seaon started in a blaze of glory. Jr. Meds. were defeated by a 2-1 score and it looked like the team were due to repeat their success of last season. These delusions were soon settled though,

JUNIOR SCHOOL WATERPOLO TEAM

1933-34

Thompson, Boyle, Morgan, Clarke (Manager), Hollands, Eggert, Pittis.

because in the next game, Dents came from behind to win out by a 3-1 margin. This setback merely started the boys to work and after several "secret" practices they stepped out and mopped up the pool with Meds. Jr. entry to the tune of 4-0. With visions of the play-off gate dimming their sight, the boys just couldn't seem to see the goal in the return joust with Dents, and after one of the roughest and closest games ever witnessed, Dents were fortunate enough to come out at the long end of a 2-1 score. Thus ended the activities as far as we were concerned.

As for the personnel of the team, at centre, Carl Eggert, a newcomer and one of the fastest men at the University, was supported by Pat Morgan and Maurice Hollands on the wings. The opposing centres were checked by Ken Clarke at rover. A stonewall defence was put up by Ron Boyle and Ralph Pittis, who checked the opposing wing men to the well known "frazzle". In goal, the one and only "Specs" Thompson, who, although a freshman at the game, turned in several star games. "Chuck" Hoag, a valuable performer, filled in on the forward line and came through with many stellar efforts. Kierney, Young, Scott and Sweet helped in the pinches and will make their presence felt in next year's series.

Although they did not win out in their group, the team derived a lot of experience from their series, and if good luck attends their examination efforts, several will be found on the Sr. School line-up next year.

E. H. J. Clarke,
*Manager.*

# *Senior School Water Polo*

It has been said by those in the "know" that the Engineer by nature is a true economist. Water polo as played by Sr. School gave an excellent practical example of this fact. The combined forward line of "Hawk-eye" Hooper, "Tubby" Bell, and "Porpoise" Hawke would pop in so many goals and then no more. As a result when School met Trinity in the finals the economical spirit was by then so instilled that no goals were popped. Other well-known facts were also proved during the exhibition game on School Nite, but chiefly that alcohol and water are not miscible.

Nearly everyone on the team has at one time or another played on the Jr. Intercollegiate water polo team so that good co-operation was noticeable from the beginning of the season. The forward line was made up of strong swimmers, and with the aid of the rover scored on some good plays. The defence along with the goalie rounded out an evenly balanced team. Unfortunately, Trinity was faster and better and so after an extremely brilliant beginning, Sr. School was left holding the bag.

Doug. Bruce,
*Manager.*

SENIOR SCHOOL WATERPOLO TEAM

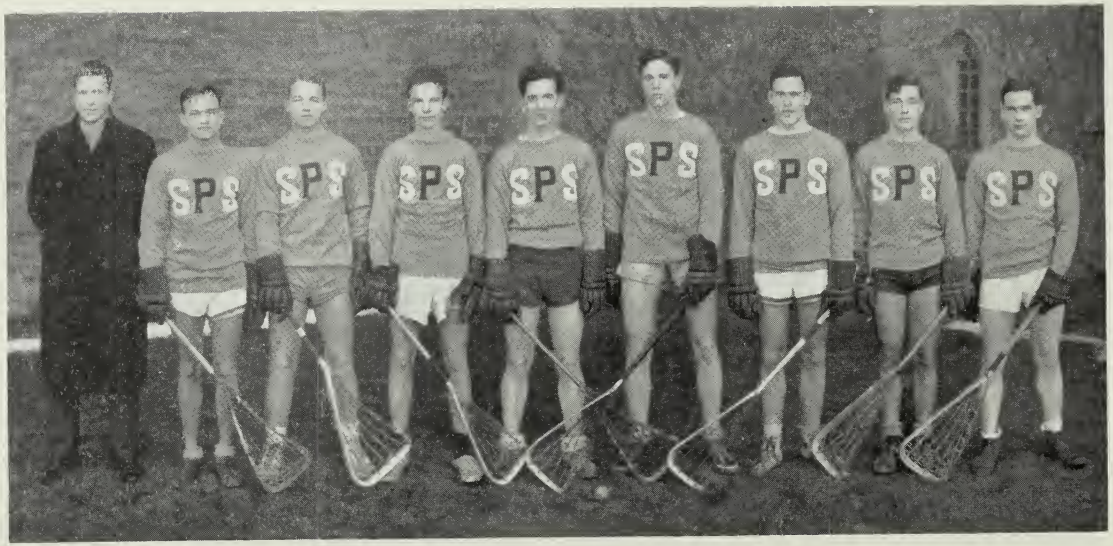
Eckhardt Trophy Finalists 1933-34

*Back Row*: Webber, Charters, Woods, Bell.
*Front Row*: Hooper, Bruce (Manager), Fraser (Coach), Brown, Hawk.

SCHOOL SWIMMING TEAM

Junior Interfaculty Champions 1933-34

*Back Row*: Woods, Bell, Welch.
*Front Row*: Eggert, Hogfer, McCraig, Jennings, Rider.




JUNIOR SCHOOL LACROSSE TEAM

1933-34

A. W. Jacob, G. W. Walkey, R. H. Miller, A. G. Breakey, R. E. Bates, B. J. F. Hamilton (Manager), G. R. Bruce, S. Murray, W. F. Taylor.

# S.P.S. Swimming Team

Under the guidance of Paul Hooper, the swimming team got away to a late start, which possibly accounts for the late finish. The Junior team which performed in the fall term was successful inasmuch as it carried off the laurels (and the hardies of the other faculties). The Senior team were, however, not so fortunate, and as Trinity had all the aces up her sleeve, the Fitzgerald Trophy traded hands for the first time in many years. It would seem that Trinity is getting water on the brain. Eggert, Hollands, Rider, Woods, Jennings, McCuaig and Welch upheld the honour of School.

DOUG. BRUCE,
*Manager.*

# Junior Lacrosse

A strong, battling, though not exactly finished team was furnished by Junior School in the Lacrosse League.

Interest in the Indian pastime around the Campus has increased noticeably and with the material around School a Dafoe Cup winner should be provided in the next couple of years.

Junior School were stacked this year against Knox, U.C., and Meds, a strong group for a junior team with championship ambitions. The Schoolmen certainly showed their battling spirit and consequently the penalty bench wasn't given much of a chance to cool off.

The story goes that School won from Meds by the scores 5-3 and and 11-9, defeated U.C. by 16-9 in the first game and tied the second 11-11, the best played game of the season. Against Knox, the ultimate league winner, School did not fare so well, and were defeated by the scores 14-8 and 16-10, showing that they were far from being a weak team.

The team played well together with no really outstanding stars. Murray and Hamilton both made positions on the Varsity, all star, intercollegiate undefeated champion lacrosse team.

The Team: Goal, Miller; Defence, Bruce, Hamilton, Sharpe; Forwards, Jacob, Taylor, Murray, Walkey, Bates, Breakey, Stroud.

B. HAMILTON,
*Manager.*

SENIOR SCHOOL LACROSSE TEAM

1933-34

Paul Walters (Manager), Vic MacLachlan, Keith Kennedy, Jack McMillan, Clayt. Knapp, Don Summerville, Ed. Caldwell, Tom Bell, Bob Webber, John Lilley.

# *Senior Lacrosse*

In the opening game, minus Bell, Caldwell, Muir, Webber and Birss, School gave Victoria, last year's finalists, a great struggle. Vic led 5-0, but the Engineers tied it up only to fade and lose 6-5.

Forestry entertained(?) School in the next two games! The Woodsies displayed a finished attack which was one principally of clubbing, punching and slashing. School had to go soft and assimilate a lot of abuse in order to make sure of winning these two games by 7-5 and 11-7 scores. This is borne out in Lemma No. 9, which states, "the penalty bench always stands with outsretched arms ready to receive any loyal Schoolman whether he has been guilty of a rule infraction or not." The final game with Vic. was a night mare for School. Vic. led 5-0 at the end of the first five minutes. School tied it up, dominating the play till the end of the game. As a win was necessary we were thus eliminated.

In closing, I would like to give three men, Dolbear, Charters and Brownlee, a great big vote of thanks for their faithfulness and readiness, to help at all times.

PAUL WALTERS,
*Manager.*

# *Senior School Baseball*

This is the first year Senior School has not won its group in the University Indoor Baseball League for many a moon. However, we will skip that. The season opened with the Spalding Cup appearing within easy grasp but it faded completely without even a fair fight. However, they win the prize for being the smartest uniformed team in the league.

As usual the team was grouped with Pharmacy and Dents. In former years these faculties have fielded teams which offered little resistance and just provided practice for future games. However, this season it was only after great difficulty and a final spurt in the last innings that Pharmacy was defeated, 21 to 16 and 6 to 5. The two losses to the Dental students were close, as the scores of 11 to 10 and 9 to 7 indicate. School only needed to give that extra spurt to win but the games were both called as victory seemed within grasp.

The majority of the team have been playing baseball together for a long time and it is hard for them to graduate without winning the championship. Hugh Johnston and Reg Miller were always on

SENIOR SCHOOL BASEBALL TEAM

1933-34

*Back Row*: R. L. Miller, V. D. MacLachlan, T. J. Wells, W. M. Burgoyne, D. N. Cooke, W. O. McBride, P. H. Hawker.

*Front Row*: T. J. Carbone (Coach), T. C. Muir, H. H. Johnston (Captain), J. P. Borbey, H. T. Turley, W. S. Smith (Manager), K. B. Kennedy.

*Absent*: H. R. Collins, J. M. Doughty.

JUNIOR SCHOOL BASEBALL TEAM

Group Winners 1933-34

*Back Row*: Wheaton, Hestler, Jaffe, Mundy.
*Front Row*: McLaughlin (Captain), Miller, Carveth (Manager), Troster, Pidduck, Quance, McMillin.

JUNIOR SCHOOL HOCKEY TEAM

1933-34

KERR, WHEATON, PRESS, WOODS, ANGUS, TERRY, BRUNETTE, DAVIDSON, AITKEN, STAVERT.

the job behind the plate to receive whatever Phil Hawker, Bill Burgoyne or John Doughty had in the line of curves or upshoots. John Borbey and Jack Wells, our two southpaws, covered first base in an admirable fashion. Keith Kennedy, Tom Carbone or Bub Turley let no one past second or third base without good reason. Vic MacLachlan, Hal Collins and Tom Muir proved a sure barrier between the bases as shortstops. The outfield was always a stronghold with Bill McBride and Don Cooke.

It was certainly misfortunate that this team was eliminated so early in the series as they are indubitably of championship calibre. However, they always played better baseball during practice hours than when in the heat of battle. Nevertheless, they deserve the highest praise for their showing throughout the season. May the team have a little better luck next year.

W. Stanley Smith,
*Manager.*

# *Junior School Baseball*

The old custom of winning the group was again repeated by Jr. School, but the opposition met in the play-offs was too strong.

At the end of the regular schedule the three teams were tied for group honours. In the play-downs, Jr. U.C. defeated Jr. Meds., while Jr. School who had drawn a bye, defeated Jr. U.C. by 10-4 to qualify for the regular play-offs. However, Sr. U.C. defeated them in the first game 5-2, and Jr. Vic. eked out the odd run in an extra-inning game to eliminate them.

The batting strength, a usual characteristic of School baseball teams, took this year off and the splendid pitching of McLaughlin and McMillin with the good fielding of the rest of the team was not sufficient to carry the team into the finals. The rest of the team consisted of Quance, regular catcher; Wheaton, sub-catcher; Carveth, Miller, Willmott and Purcell on the bases; Marks, Troster, DeLuca as shortstops; Pidduck, Jaffe and Mundy in the field.

The players fought hard in every game as their opponents and umpires will testify. May it be said that they played the game, however, and after all that's what counts. If next year's team produces some batters it seems assured that School will have the Spalding Cup tucked away when another year rolls around

B. H. Carveth,
*Manager.*

SENIOR SCHOOL HOCKEY TEAM

Jennings Cup Semi-Finalists 1933-34

Wilson (Def.), Johnston (R.W.), Hodgson (L.W.), Dolbear (Def.), McNichol (Centre,-Captain), Paterson (R.W.), Vessie (Goal), Caldwell (L.W.), MacLachlan (Centre), Kennedy (Def.), Hewitt (Def.), Bridgland (Manager).

# *Junior School Hockey*

The Junior School team, while not entering the play-offs, proved that they were one of the best teams in the Interfaculty series. Their only loss was by a score of 2-1 to Victoria and this in a very strong group. They were also one of the two teams to hold to a draw the strong Vic outfit, which eventually won the Jennings Cup.

Jr. School were fortunate in having such a good goal-keeper as Angus, who made many marvellous saves. A defence of Press, Aitken and Brunette was strong defensively and their rushes were always dangerous scoring threats. The first string forward line of Stavert, Kerr and Davidson were a constant worry to opposing goalies, while the alternates, Terry, Willmott, Wheaton and Woods, played heads-up hockey.

Much credit is due Johnny Stavert, whose coaching was as good as his playing, and that is saying plenty.

C. Brunette,
*Manager.*

# *Senior School Hockey*

After being just nosed out of the group leadership for three consecutive years by Dents, Sr. School broke the "Jinx", and had high hopes of continuing the march throughout the season. This year the group was composed of three very evenly matched teams, School, U.C., and Dents, and the winners were not determined until the final game.

School got off to a good start when they chose Harp McNichol as their captain. After dropping one game to Dents in the first half of the schedule, resulting in a three-cornered tie, School came back strongly to win three straight games in the second half.

Entering the playoffs with Trinity, School took another step toward the top, winning the two-game series 5-3. Victoria, however, provde the stumbling block and after two fast, hard-fought games, in which no alibi was necessary, School was defeated 2-0 in both games, by last year's victors.

To pick individual stars would be extremely difficult. However, Vessie's cool work in goal and Hewitt's dangerous rushing and shooting were features of the season's play. The biggest blow of the season came when Freddie Murray was forced to retire early in the season due to ill health. The players were: Forwards—Hodgson, McNichol, Johnston, Murray, Caldwell, MacLachlan, Paterson, King; Defence—Kennedy, Hewitt, Dolbear, Wilson; Goal—Vessie, Welch.

C. J. Bridgland,
*Manager.*

SCHOOL SOCCER TEAM

1933-34

*Back Row*: Johnstone, Johnston, Kierney, Davey, Millen.
*Front Row*: Prof. E. A. Allcut (Hon. Coach), Maynard, Bowen (Captain), Brawley, Jaffe, M. Ward (Coach).

# School Soccer

With the opening of the season it was seen that not only had we lost several men through graduation, but that three others had unexpectedly not returned to School.

This severe handicap was partly overcome by a good turnout of Freshmen, and we set to work to round out a team. Practices went on during every afternoon and Professor Allcutt and Matt Ward came out to assist us with chalk talks and suggestions during the practices.

Our group included Victoria and Trinity Colleges, with Victoria the team to beat. This was soon proved in our first game which Victoria won 1-0. Our next game was with Trinity and we were handicapped by two of our regular players being unable to play. During the first half School played a really good smooth combination game and had a lead 1-0. Due to too much pressure for more goals in the second half, School became disorganized and finally Trinity broke away to tie up the score 1-1, which was the final score.

Following this, we again played Trinity, winning 1-0. By this time we were behind Victoria, who had won all their games. Our final die-hard game was with Victoria on November 8. School played a very steady game throughout and for a while led 1-0. Victoria was a little smoother, however, and we lost with the final score 2-1.

For the first time since 1930, we have had men on the Intercollegiate Team, three men in all making that team. Encouraged by this and also by the fact that there will be practically no loss from graduation, School should go far next year.

Let's break the six-year monopoly that Knox has on the championship.

J. A. C. Bowen,
*Manager.*

# S.P.S. Gym Team

This year, contrary to custom, our gym team did not win the Harold A. Wilson Trophy, having to be content with a close second.

However, the members were chosen to represent Varsity on the Intercollegiate team which won the championship. The Ontario meet found Lewis, one of our gymnasts, taking third place honours. Beard and Barber, the other members, were unable to enter due to injuries. Next year we hope to have a winning team.

SCHOOL GYMNASTIC TEAM
1933-34
A. B. Lewis, G. F. Beard (Captain), W. H. Barber.

SCHOOL RIFLE TEAM
INTERFACULTY CHAMPIONS MITCHELL CUP WINNERS
*Left to Right*: W. V. Thompson, G. A. Clark, R. L. Broad, F. B. Pickett, W. R. Tutton.

# *Rifle Team*

The activities of the Rifle Association started with a "bang" shortly after School started. Practices were held at Long Branch during October. The outdoor season finished at the end of the month with the interfaculty outdoor match.

The indoor shooting commenced in the Hart House Range the following week. Through the kindness of our Honourary Coach, Major Utton, and the condition of the club finances, we had three new B.S.A. rifles with which to start the indoor matches.

As usual there were three monthly shoots formerly known as spoon shoots. This year cups were given and Schoolmen were there to get all they could, and they sure did. The Mitchell Cup, emblematic of the interfaculty indoor championship, was again won by School, making it the third successive time in this event.

Much interest was added this year in that the U.T.R.A. entered a team in the Toronto Small Bore League. The Schoolmen were right in there again; the entire Mitchell Cup team and several other Schoolmen making up more than half of this team. At the time of writing the U.T.R.A. was in second place in the league and still going strong.

The banquet, which concluded the year's activities, was a wonderful success, a swell dinner, good *short* speeches and plenty of prizes distributed. This year's shooting is over, but next fall is surely coming and when it does let's go, Schoolmen! Let's make next year School's year as far as the Rifle Club is concerned. If you can shoot we need you. If you can't we will teach you.

George Clark.
*Manager.*

# UNIVERSITY OF TORONTO ENGINEERING SOCIETY

## OPERATING STATEMENT SUPPLY DEPARTMENT

### APRIL 1, 1933 TO MARCH 31, 1934

| | | |
|---|---|---|
| Sales | | $11,682.27 |
| Inventory, April 1, 1933 | $ 2,307.71 | |
| Purchases | 8,905.22 | |
| | $11,212.93 | |
| Less Inventory, March 31, 1934 | 2,328.11 | |
| Cost of Goods Sold | | 8,884.82 |
| Gross Trading Profit | | 2,797.45 |
| Salaries | | 1,365.00 |
| Net Operating Profit | | $ 1,432.45 |

## STATEMENT OF INCOME AND EXPENDITURE

### APRIL 1, 1933 TO MARCH 31, 1934

INCOME

| | | |
|---|---|---|
| Net Operating Profit from Supply Department | $ 1,432.45 | |
| Fees | 1,765.00 | |
| Interest and Discount | 211.37 | |
| School Night—Surplus | 22.23 | |
| | | $ 3,431.05 |

GENERAL OPERATING EXPENSES

| | | |
|---|---|---|
| General Expenses | $ 317.90 | |
| Grants to Affiliated Clubs | 100.00 | |
| Donations | 67.63 | |
| Dinner—Deficit | 313.71 | |
| Election Expense | 149.01 | |
| School At-Home | 214.29 | |
| Photographs | 312.70 | |
| Publications | 769.54 | |
| Depreciation—Office Equipment | 92.43 | |
| Insurance | 22.60 | |
| Printing and Stationery | 37.10 | |
| | | $ 2,396.91 |
| Excess of Income over Expenditure to Surplus Account | | 1,034.14 |
| | | $ 3,431.05 |

# UNIVERSITY OF TORONTO ENGINEERING SOCIETY

## BALANCE SHEET

### AS AT MARCH 31, 1934

### ASSETS

| | | |
|---|---|---|
| CURRENT ASSETS | | |
| Cash on Hand | $ 95.93 | |
| Bank Balance—Savings | 1,783.10 | |
| Accounts Receivable | 696.35 | |
| Merchandise Inventory | 2,328.11 | |
| | | $ 4,903.49 |
| INVESTMENTS—Dominion Government and Government Guaranteed Bonds | 4,000.00 | |
| Add Accrued Interest, etc. | 91.17 | |
| | | 4,091.17 |
| FIXED ASSETS | | |
| Office Equipment | 1,288.57 | |
| Less Reserve for Depreciation | 772.43 | |
| | | 516.14 |
| DEFERRED EXPENSE | | |
| Unexpired Insurance | | 40.00 |
| | | $ 9,550.80 |

### LIABILITIES AND SURPLUS

| | | |
|---|---|---|
| CURRENT LIABILITIES | | |
| Accounts Payable | $ 815.00 | |
| Bank—Overdraft Current Account | 297.50 | |
| | | $ 1,112.50 |
| Surplus Account | | 8,438.30 |
| | | $ 9,550.80 |

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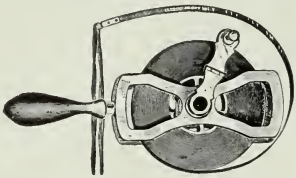

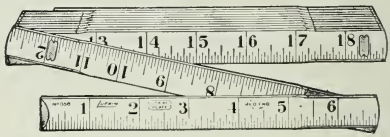

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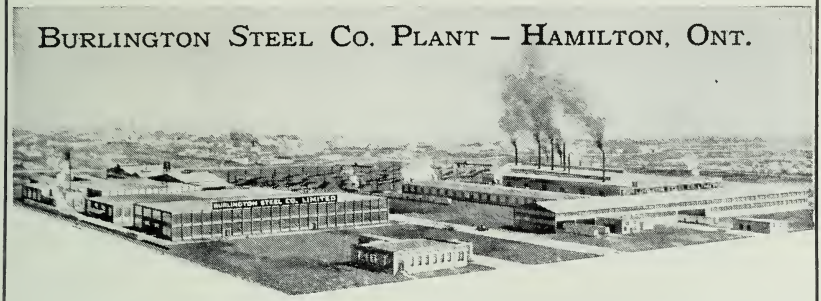


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